Pier 53–55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project 1993 Data

Elliott Bay/Duwamish Restoration Program

Prepared for the
Elliott Bay/Duwamish Restoration Program Panel
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PREFACE

This report was prepared by the King County Department of Metropolitan Services (Metro). It documents the results of the 1993 environmental monitoring of the Pier 53-55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project. Monitoring in 1993 was the second year of monitoring in a scheduled 10-year program. Project construction information, project background, and 1992 monitoring results appear in the report, *Pier 53-55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project* (Metro, 1993).

This project is conducted under the administration of the Elliott Bay/Duwamish Restoration Program Panel. The Panel is composed of representatives from the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the Muckleshoot Indian Tribe, the Suquamish Tribe, the Washington State Department of Ecology, the City of Seattle, and Metro. The Panel's goals are to identify, prioritize, and implement sediment remediation and habitat development projects and associated source control measures in Elliott Bay and the Duwamish River.

ACKNOWLEDGMENTS

Many individuals at several different agencies were part of the Pier 53-55 Sediment Cap and Enhanced Natural Recovery Area remediation project. We wish to acknowledge the contributions of the following individuals to the project and the production of this document.

Sample Collection

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Contractors

Benthic taxonomy collection	Pentec Environmental, Inc.
Benthic taxonomy identification	Marine Taxonomic Services
Diving for core samples and video survey	Global Diving
Total organic carbon analysis	AMTest
Particle size distribution analysis	AMTest

Elliott Bay Duwamish Restoration Panel Members

The Elliott Bay/Duwamish Restoration Panel approved funding for the Pier 53-55 project. The voting members were as follows:

Dan Cargill	Washington State Department of Ecology
Glen St. Amant	Muckleshoot Indian Tribe
Margaret Duncan	Suquamish Tribe
Robert C. Clark Jr.	National Oceanic and Atmospheric Administration
Alisa Ralph, Curtis Tanner	U.S. Fish and Wildlife Service
Bob Chandler, Cheryl Paston	City of Seattle
Bob Swartz	Metro

Sediment Remediation Technical Working Group

The Sediment Remediation Technical Working Group reviewed and recommended that the Panel fund the Pier 53-55 project. The group members were as follows:

Pat Romberg, chair	Metro
Pat Cagney	U.S. Army Corps of Engineers
Randy Carman	Washington Department of Fisheries
Bob Chandler, Cheryl Paston	City of Seattle
Robert C. Clark Jr., Mike Francisco, Gail Siani	National Oceanic and Atmospheric Administration
Doug Hotchkiss	Port of Seattle
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Joan McGilton	The Boeing Company
Teresa Michelsen, Rick Vining, Joanne Polayes-Wien	Washington State Department of Ecology
Glen St. Amant	Muckleshoot Indian Tribe
Margaret Duncan	Suquamish Tribe
Justine Barton	U.S. Environmental Protection Agency
Melany Lee, Rick Singer	Washington State Department of Transportation

EXECUTIVE SUMMARY

In 1993, monitoring activities were conducted at the Pier 53-55 remediation area as part of a 10-year monitoring program. The area comprises 4.5 acres of contaminated bottom sediment in Seattle's Elliott Bay that were capped with clean sand in March 1992. The capped sediments are located offshore of Piers 53, 54, and 55 in downtown Seattle (Figure 1). The cap is designed to be 3 feet thick over the 2.9 acres farthest offshore and 1 foot thick over 1.6 acres nearshore. The thinner part of the cap is known as the enhanced natural recovery area (ENR).

The purpose of the monitoring program is to determine how stable the cap is, how well it is functioning to isolate the contaminated sediments, whether the cleanup continues to meet state sediment standards, and how the cap is biologically repopulated. It is also a means to evaluate the rate of possible recontamination. Bottom stakes were installed to measure cap thickness and stability, and sampling stations were established to monitor both chemistry and taxonomy (Figure 2). Results of 1993 monitoring were compared with results of baseline monitoring conducted in 1992 shortly after the cap was placed.

METHODS AND RESULTS

Cap Thickness and Settlement

Cap thickness and settlement were measured directly using 13 measuring stakes and settling plate assemblies that were installed in the target capping area before the cap was placed (not shown on Figure 2). Divers measured both cap thickness and settlement at each of the 13 stakes soon after capping in 1992 and again a year later in 1993 to determine whether the cap is eroding and the amount the seafloor is settling.

Most of the changes in cap thickness were in the range of a few hundredths of a foot. Four measured changes were equal to or slightly greater than 0.1 foot, and one measurement in the southeast corner the cap indicated a 0.5-foot increase in cap thickness. Several stakes at the southern edge of the cap showed signs of disturbance. It is likely that the increased cap thickness and stake disturbances resulted from demolition of a wing wall as a part of pier construction activities at the downtown Seattle ferry terminal.

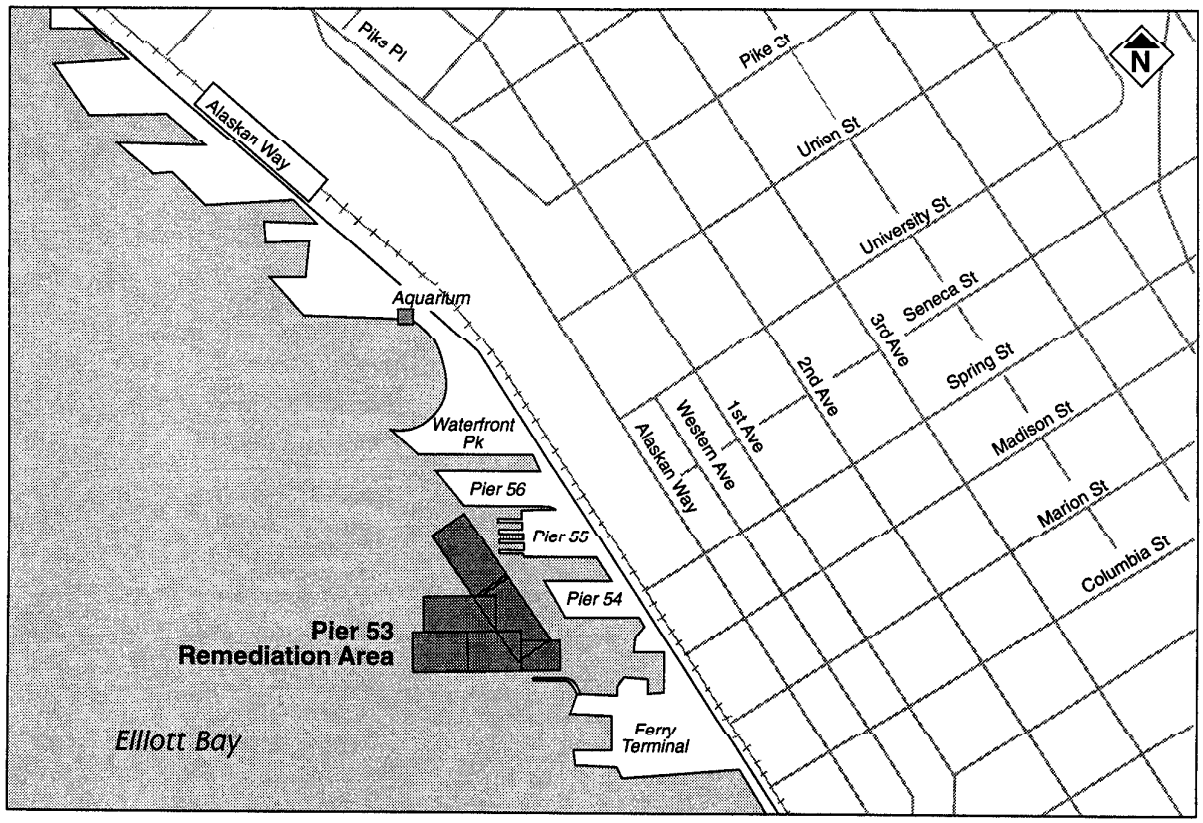

Figure 1. Location of Remediation Area

The overlying burden of 20,000 cubic yards of sand caused some seafloor settlement as anticipated. In the 3-foot cap area, settlement ranged from 0.3 to 0.14 foot. Settlement in the ENR ranged from 0.2 to 0.02 foot. The ENR probably settled less than the 3-foot cap because of the smaller amount of overburden.

Core Chemistry

Cores were taken at five stations across the 3-foot cap and ENR (C1 through C5). Each core extended completely through the cap and into the underlying contaminated sediments by at least 1 foot. The cores were divided into 6-inch-long sections. For each core, one section from within the cap just above the cap/under-cap interface and one section from below the cap were analyzed for organic, metal, and conventional parameters.

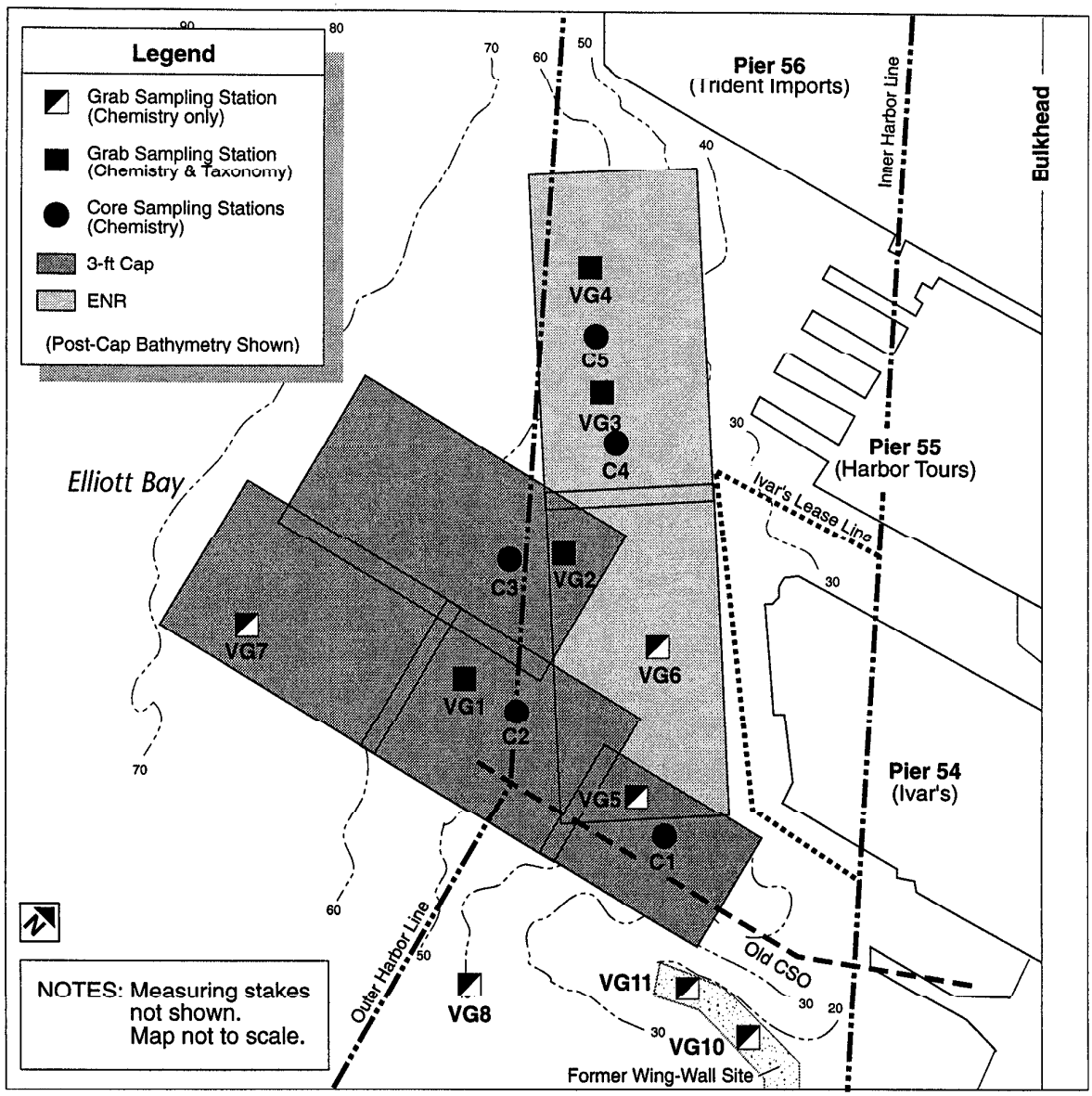

Figure 2. Sampling Stations

Analysis of the 1993 core samples showed that no chemicals are migrating up into the cap from the underlying contaminated sediments. The analysis showed a dramatic contrast between the high chemical concentrations in the under-cap samples and the low or undetected concentrations within the cap. Only eight organic compounds were detected in the cap, compared to 27 compounds detected under the cap. The concentrations of the organic chemicals found in the cap were low, ranging from below reporting detection

limits to 68 µg/kg dry weight. Most metals found in the cap were in concentrations at or below detection limits. Concentrations were much higher under the cap where several organic compounds and metals exceeded state sediment quality standards and cleanup screening levels.

Surface Sediment Chemistry

Ten surface sampling stations were monitored: seven on the 3-foot cap and ENR (VG1 through VG7) and three outside and south of the remediation area (VG8, VG10, and VG11). The top 2 cm of sediment from three grab samples were composited from each sampling station. The composite samples were analyzed for organic, metal, and conventional parameters.

During sampling at one station in the southeast corner of the remediation area (VG5) and two stations outside the remediation area (VG10 and VG11), the monitoring team discovered visible evidence of creosote contamination. Samples taken at VG5 contained small pieces of broken creosote-treated piles. Also, oil droplets appeared on the sediment surface as the water was drained from the samples.

A thick black ooze was found on the surface of the sediments at VG10 and VG11, south of the remediation area and near VG5. The ooze had the consistency of mayonnaise and had a very strong coal-tar creosote smell. Stations VG10 and VG11 were located where the auxiliary ferry loading ramp wing wall was removed a few months prior to sampling.

The results of the chemical analysis of the surface samples showed that the entire remediation area was recontaminated and that the southeast half of the remediation area exceeded state sediment standards.

The highest chemical concentrations were found outside the remediation area at VG10 and VG11. Moving alongshore to the north and offshore to the west, the concentrations decreased consistently with distance from the former wing-wall site. VG5 showed the highest chemical concentrations of all stations within the remediation area.

The analytical data showed much higher concentrations of LPAHs relative to other organic compounds. For the three stations VG5, VG10, and VG11, LPAHs exceeded the cleanup screening levels 17 times compared to 5 times for all other organic chemicals.

The source of the LPAHs appears to be coal-tar creosote, which is used to coat and protect wood piles in the marine environment. Up until early 1993, the auxiliary ferry terminal loading ramp wing wall, constructed of about 400 wood piles, was located about 150 feet south of VG5. It is highly likely that when the wing wall was removed, the creosote-contaminated sediments at the base of the piles were stirred up into the water column and resettled onto a broad area surrounding the wing-wall site.

Another possibility is that the construction activities stirred up deeper contamination. Core samples collected in 1994 as part of a Washington State Department of Transportation (WSDOT) investigation into the source of the contamination showed elevated PAH concentrations in the sediment from the surface down to 20 feet deep. This contamination is apparently from historical activities along the Seattle waterfront.

Benthic Recolonization

Benthic taxonomy samples were taken at four surface sampling stations across the remediation area. Two stations are in the ENR (VG3 and VG4), and two stations are in the 3-foot cap (VG1 and VG2). Five replicate samples were taken from each station. The samples were analyzed for the number of individual organisms, for the number of species, and for biomass weight. In addition, a diver, supported by a diving assistant aboard a dive boat and a research crew aboard Metro's *RV Liberty*, conducted a video camera survey along four downslope transects in the remediation area.

A total of 215 species were counted in the remediation area. Polychaetes had the greatest number of species (123), while there were 45 mollusk species and 40 crustaceans species.

Between the 1992 baseline and 1993 studies, the average number of individuals per sample at all stations increased by approximately 400 percent, the number of species increased by 55 percent, and the biomass increased by 30 percent. Comparing the pre-cap data to the 1993 data, the average number of individuals per sample and the total number of species were higher in 1993 than before the cap was placed. Biomass, however, was higher in the pre-cap study by 600 percent.

Productivity differences between the 3-foot cap and the ENR were not apparent. Spatially, the least productive stations were at the north end and the south end of the remediation area and the most productive were in the middle of the remediation area. It is not clear if reduced numbers of individuals, species,

and biomass at the southernmost station were associated with its proximity to the ferry terminal wing-wall site. No benthic taxonomy stations were located near the highest levels of contamination in the remediation area, and, consequently, biological effects of the contamination could not be determined.

The diver-held video camera survey showed many burrows, tubes, and other evidence of benthic life on the cap. Many flounder, several types of crabs, anemones, nudibranchs, and starfish were taped. Many more plants were rooting into the sand than was shown in the video survey taken in 1992 soon after the cap was placed. In comparison with the surrounding areas, the cap is relatively clear of debris and marine vegetation. Images taken along the cap edge closest to the piers showed much more trash, old pilings, and other wood debris, which appear to provide attachment locations for marine vegetation.

CONCLUSIONS

Conclusions from the 1993 monitoring of the Pier 53-55 remediation area are as follows:

- The 3-foot cap and ENR are stable. They are not eroding or sinking into the native bottom muds. Some indication of disturbance and additional thickness in the southern edge of the area were most likely caused by demolition of the ferry terminal wing wall.

- Contaminants are not migrating from the underlying sediments up into the 3-foot cap or ENR. Samples showed a dramatic contrast between the high concentrations in the underlying sediments and the low or undetected concentrations in the cap and ENR. Results of core samples of the underlying sediments indicated more contaminants and higher concentrations in the 1993 under-cap samples than in 1992. This may be due to core sampling procedures.

- The entire surface of the 3-foot cap and ENR have been recontaminated, as indicated by chemical analyses of 2-cm deep surface samples. These samples showed that the southeast corner of the remediation area exceeded state sediment standards. Chemical concentrations and visual observations showed a strong correlation to the demolition of the ferry terminal wing wall. Cleanup of the cap and the ferry terminal area is being discussed by

WSDOT, the Washington State Department of Ecology, and the Elliott Bay/Duwmish Restoration Program Panel (the Panel).

- Despite the recontamination, benthic taxonomy counts indicate that the number of individuals, the number of species, and biomass were greater in 1993 than in the 1992 baseline study. The number of species and individuals was also higher in 1993 than before the cap was placed, although biomass was lower. These increases show that improved sediment quality has had a positive effect on the benthic community. However, the benthic sampling stations were not located near the areas of highest recontamination, and, consequently, biological effects of the contamination could not be determined.

- Pile removal can cause significant recontamination of cleanup projects. This conclusion prompted the Panel to request that a pile removal workshop be held. In February 1994, a workshop cosponsored by the Panel, WSDOT, and the Port of Seattle brought together project sponsors, construction contractors, and regulatory agencies to discuss environmental impacts and possible solutions of pile removal. Additional meetings are being held to develop guidelines that will minimize resuspension and redistribution of contaminated sediment during pile removal and pier renovation.

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SECTION 1

INTRODUCTION

In March 1992, contractors for the U.S. Army Corps of Engineers slowly placed 22,000 cubic yards of clean sand offshore of Piers 53, 54, and 55 in Elliott Bay on Seattle's downtown waterfront, capping 4.5 acres of chemically contaminated bottom sediments. This action, known as the Pier 53 project, was the culmination of over 4 years of study and planning by many agencies, including the City of Seattle Department of Engineering, the King County Department of Metropolitan Services (Metro), the U.S. Army Corps of Engineers (the Corps), the Washington State Department of Ecology (Ecology), the Washington State Department of Natural Resources (DNR), the Washington State Department of Fisheries, and the U.S. Environmental Protection Agency (EPA).

The purpose of this report is to document the methods, results, and conclusions of monitoring conducted on the Pier 53 project site in 1993 as part of the monitoring program established for the project. For further background information, see *Pier 53-55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project* (Metro, 1993).

PROJECT SITE

The project site is an east-west-trending rectangular and trapezoidal area located offshore of Piers 53, 54, and 55 (Figure 1-1). The site is west and slightly north of the intersection of Madison Street and Alaskan Way in downtown Seattle. The project consists of a 3-foot-thick sediment cap covering the 2.9 acres farthest offshore and an experimental 1-foot-thick enhanced natural recovery area (ENR) covering the 1.6 acres nearshore.

PROJECT BACKGROUND

Planning for a remediation project along the Seattle waterfront began as part of Metro's Toxic Sediment Remediation Program, which was formed to coordinate and plan multiagency efforts to clean up contaminated sediment in Elliott Bay and the lower Duwamish Estuary. An interagency committee was

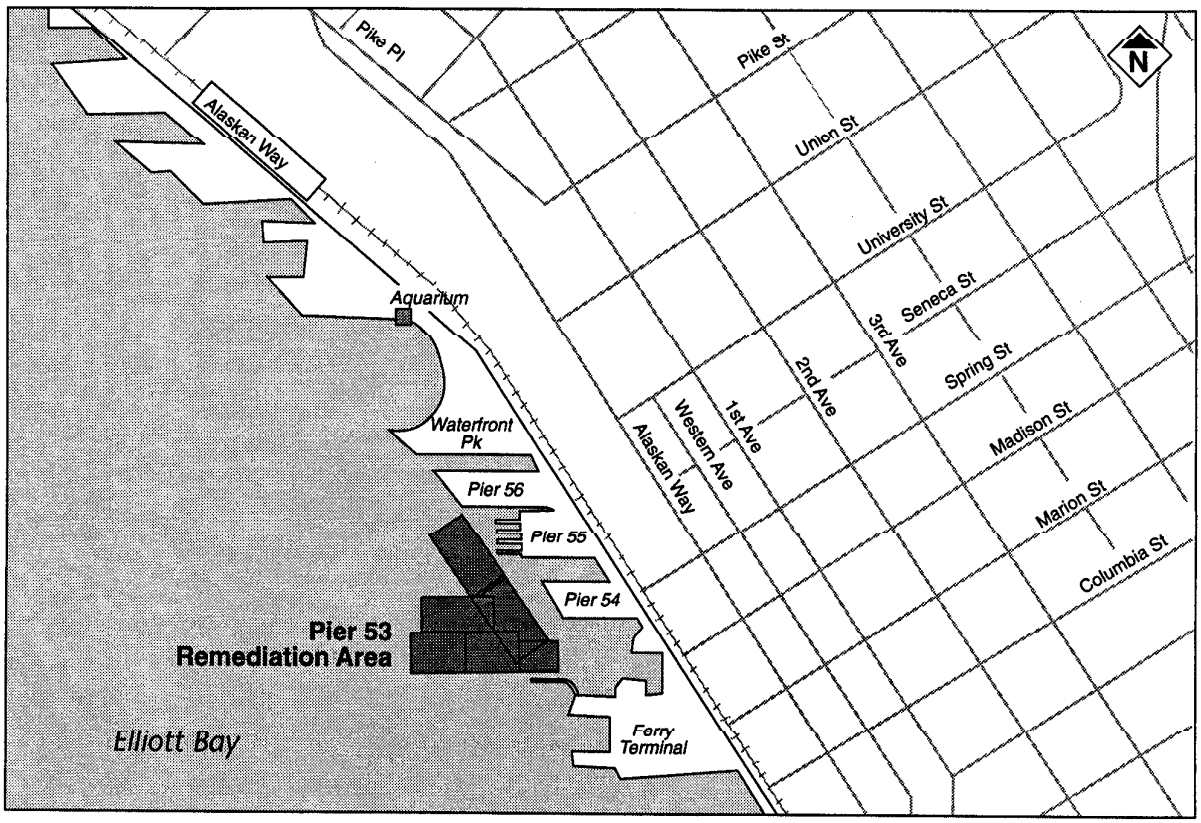

Figure 1-1. Location of the Pier 53 Remediation Area

formed to provide guidance for this program. The Denny Way sediment cap—located north of Seattle's downtown waterfront—sponsored by Metro, and constructed in 1990, was the first project completed under the Toxic Sediment Remediation Program.

The first major step in planning a new sediment remediation project along the Seattle waterfront was to contract Parametrix, Inc., to develop a risk assessment of potential remediation sites and to prioritize a list of 49 potential sites. The list was later expanded to include sites in the Duwamish River for a total of 68 sites. The sites were ranked on the basis of the number and types of chemicals present and the maximum concentration of these chemicals. Of the initial 49 sites, the two highest ranked sites were Seacrest Park, located south of the Seacrest Marina on the West Seattle side of Elliott Bay, and the Pier 53 site. A preliminary remediation plan was developed for these two sites as part of the Parametrix report (Parametrix, 1992).

Planning for remediation was suspended when the National Oceanic and Atmospheric Administration (NOAA) filed a lawsuit against the City of Seattle and Metro in 1990. The lawsuit alleged damages to natural resources resulting from hazardous substances released in and around Elliott Bay and the Duwamish River from combined sewer overflows (CSOs) and storm drains. It was settled out of court in 1991. The negotiated settlement among NOAA, the U.S. Fish and Wildlife Service, the Muckleshoot Indian Tribe, the Suquamish Tribe, Ecology, the City of Seattle, and Metro created a fund designated for the cleanup of Elliott Bay and the lower Duwamish River. It also created a panel, the Elliott Bay/Duwamish Restoration Program Panel (the Panel), to administer the fund. The settlement stipulated that money for the fund would come from the City of Seattle and Metro.

After the lawsuit was settled, planning for a remediation project in Elliott Bay was revived. The Pier 53 site was chosen when the City of Seattle expressed a willingness to take the lead in implementing a capping project at the site and the Corps was willing to provide capping sand from routine maintenance dredging in the Duwamish River.

No effort was made to reassemble the initial interagency committee. Instead, the City of Seattle and Metro decided to develop plans and coordinate agencies during the permit process. The Corps was committed to complete dredging in the Duwamish River by the end of March 1992 and would dispose of the sand at the open water disposal site in Elliott Bay if no beneficial capping project was possible. Because of this dredging schedule, the time frame for acquiring the necessary permits and the review period for the permitting agencies were very short. All permitting agencies were very cooperative, and all permits were obtained.

After the Pier 53 sediment cap was installed, the project was presented to the Panel. The Panel reviewed the project and, after deciding it met certain criteria, declared that the project was eligible for reimbursement from the restoration fund. The management of the Pier 53 project then proceeded under the direction of the restoration panel with the City of Seattle as project sponsor. Metro agreed to conduct the monitoring program, which was established during the permitting process.

MONITORING PROGRAM

It was determined that environmental monitoring for the Pier 53 project should consist of short-term activities needed to place the cap and long-term activities needed to document the effectiveness of the cap. The long-term activities would include intensive sampling and observation during the first 2 years after capping, followed by less frequent monitoring thereafter. A 10-year monitoring plan was adopted and is currently under way (City of Seattle and Metro, 1992).

Monitoring Plan

The monitoring plan (Appendix A) lists seven objectives and provides an outline for the periodic monitoring report. The objectives are as follows:

- Provide pre-cap taxonomic data.
- Guide and document the cap placement and thickness.
- Document how well the 3-foot cap and ENR function to isolate contaminated sediments from migrating upward into the cap.
- Determine whether offsite chemicals migrate and accumulate on the surface of the 3-foot cap and ENR.
- Determine the amount and type of benthic recolonization that occurs in the remediation area and whether benthic recolonization differs between the 3-foot cap and ENR.
- Review and evaluate the monitoring data to determine whether the cap is functioning as expected and whether further actions are warranted in the capped area.
- Provide data that may inform and assist the Panel and other agency teams in developing future cleanup plans for Elliott Bay.

To meet these objectives, the monitoring plan required the establishment of bottom stakes for measuring cap thickness, surface sediment stations for taking samples for chemical and taxonomical analysis, and core sediment stations for taking samples for chemical analysis (Figure 1-2). Sediment chemistry data collected during monitoring were to be normalized for total organic carbon and

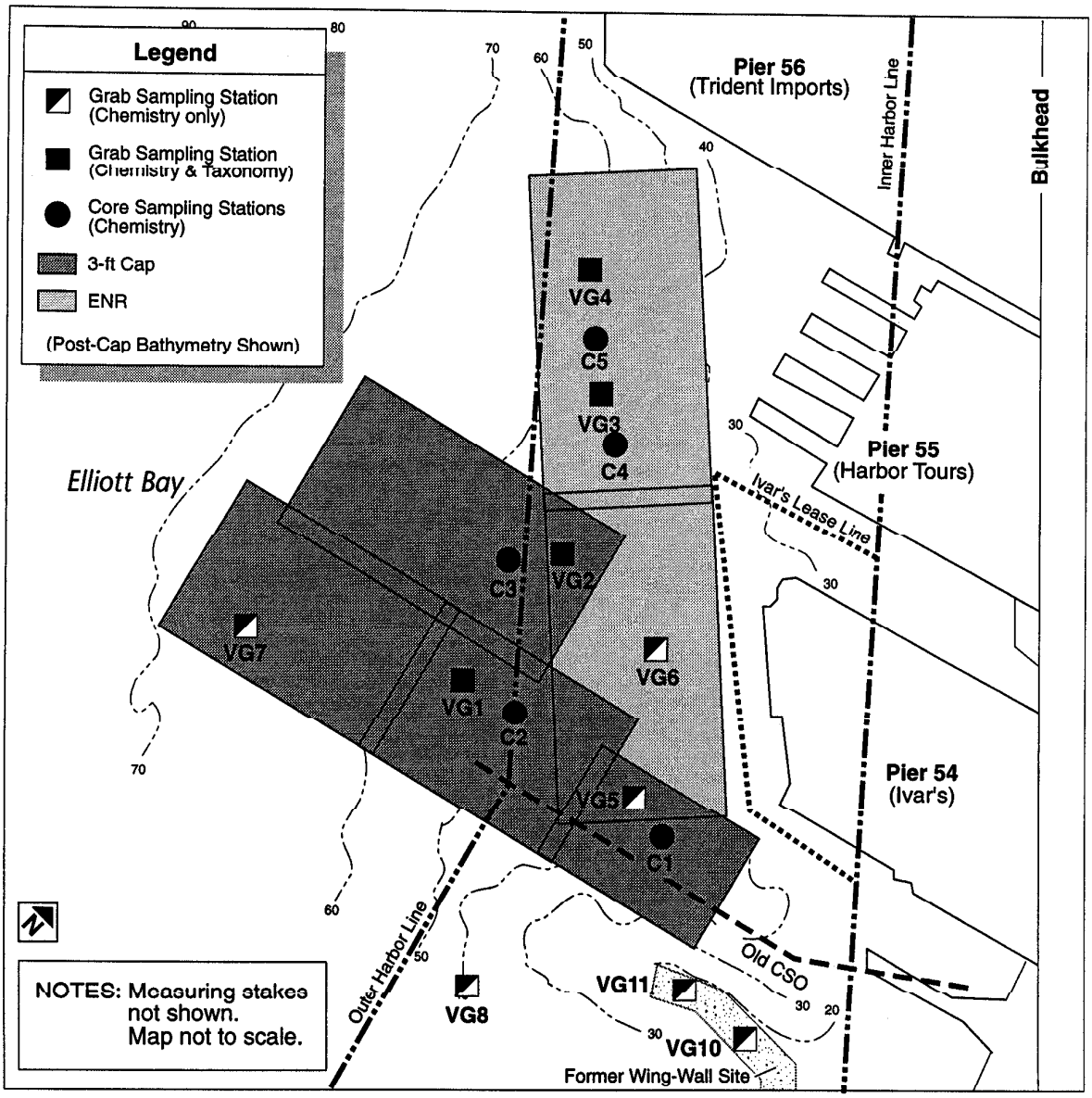

Figure 1-2. Sampling Stations

compared to the state Sediment Management Standards (SMS) (Ecology, 1991) to determine whether the site continues to meet the cleanup objectives. The SMS include the Cleanup Screening Levels (CSL) and the more conservative Sediment Quality Standards (SQS).

Status Report on the Monitoring Program

So far, monitoring activities have been conducted in 1992 and 1993 at the Pier 53 site, both before and after the cap was placed.

The first monitoring activities took place in 1992 with the collection of pre-cap benthic taxonomy and pre-cap sediment chemistry samples. During the first year after the cap was placed (also in 1992), data were collected to establish baseline conditions. Data included cap placement, thickness, and settlement; benthic taxonomy; surface sediment chemistry; and core chemistry. A video camera survey of the cap and a sediment-profile camera survey also were conducted.

The baseline chemical monitoring was completed soon after capping in May 1992. Baseline taxonomical monitoring was completed in August 1992, during the time of year when the number and biomass of benthic invertebrates would be highest. The report containing 1992 data results and discussions was issued as a draft and as a preliminary review draft to the Panel and to other regulatory agencies before being finalized in 1993 (Metro, 1993). During 1993, chemical monitoring was also conducted in May and taxonomical monitoring was conducted in August. All future monitoring will be conducted in August so that all samples can be taken at once.

Baseline cap thickness measurements and a sediment-profile camera survey taken after cap placement in 1992 showed that the cap placement proceeded as planned except for a small amount of sand that drifted offsite. The amount of sand used in the 3-foot cap and ENR was similar to the amount projected except for the area farthest offshore and in deeper water, which required more sand. The method of applying the capping sand directly from the barge worked well, and, by using available equipment, the project costs were kept to a minimum. All maps of the Pier 53 project that appear in this report include rectangles that represent the barge tracks—the areas where individual barge loads were deposited.

The pre-cap chemical analysis showed the expected high concentrations of organic and metallic contaminants at the Pier 53 site. Pre-cap sediment samples exceeded the CSL for mercury, cadmium, and silver. Post-cap baseline core samples taken in 1992 showed the expected high chemical concentrations in the under-cap samples and either undetected or low concentrations in the within-cap samples. The cap surface samples showed the cap to be clean and that the chemical concentrations were similar over the entire cap. As expected, the

within-cap core and cap-surface chemistry levels were well below the state sediment standards.

The pre-cap benthic taxonomy survey showed high numbers of species that are most likely to inhabit a stressed environment, indicating that contamination had possibly had an impact on the benthic community. The post-cap baseline benthic taxonomy survey taken in 1992 showed that recolonization was beginning but that numbers and biomass were low. The video camera survey showed that benthic recolonization was beginning at the edges of the cap and then moving inward.

SECTION 2

CAP THICKNESS AND SETTLEMENT

Once the Pier 53 cap was installed, the monitoring plan required periodic measurement of cap thickness and seafloor settlement. These measurements document changes that could compromise the integrity of the cap and its ability to isolate contaminated sediments. This section describes the cap measuring stakes and settling plate assemblies, documents cap thickness and settlement in 1993, and compares these results to the 1992 baseline measurements.

METHODS

Before the cap was placed in 1992, Metro directed contract divers to install 13 bottom stakes and settling plate assemblies in the capping target area (Figure 2-1). The stakes and assemblies measure cap thickness and seafloor settlement after cap placement. The stakes were 13- to 18-foot long (3.9 to 5.4 m), 1-inch-diameter (2.5 cm) steel pipes, pounded 8 to 13 feet (2.4 to 3.9 m) into the bottom, with 4.81 to 4.9 feet (1.46 to 1.48 m) left exposed. Settling plate assemblies were then fitted over each steel stake.

Settling plate assemblies were made of a 16-inch-diameter (40 cm) plate sitting horizontally on the pre-cap seafloor, attached to a vertical 4-inch-diameter PVC cylinder long enough to remain exposed after the cap was placed (Figure 2-2). The settling plate assembly was designed to slide down the stake as the contaminated sediments were compressed under the weight of the overlying cap. A metal clamp fastened to the steel stake marked the position of the PVC cylinder before capping. The distance between the bottom edge of the metal clamp and the top of the PVC cylinder was a direct measurement of seafloor settlement after capping.

Cap thickness was determined by measuring the length of PVC cylinder exposed above the cap surface, and then subtracting the total length of the cylinder measured before capping. (The net change in water depth can be obtained by subtracting the settlement from the cap thickness.)

Using a surveyor's rod, divers measured both cap thickness and seafloor settlement at each of the 13 stakes soon after capping in 1992 and again a year later in 1993.

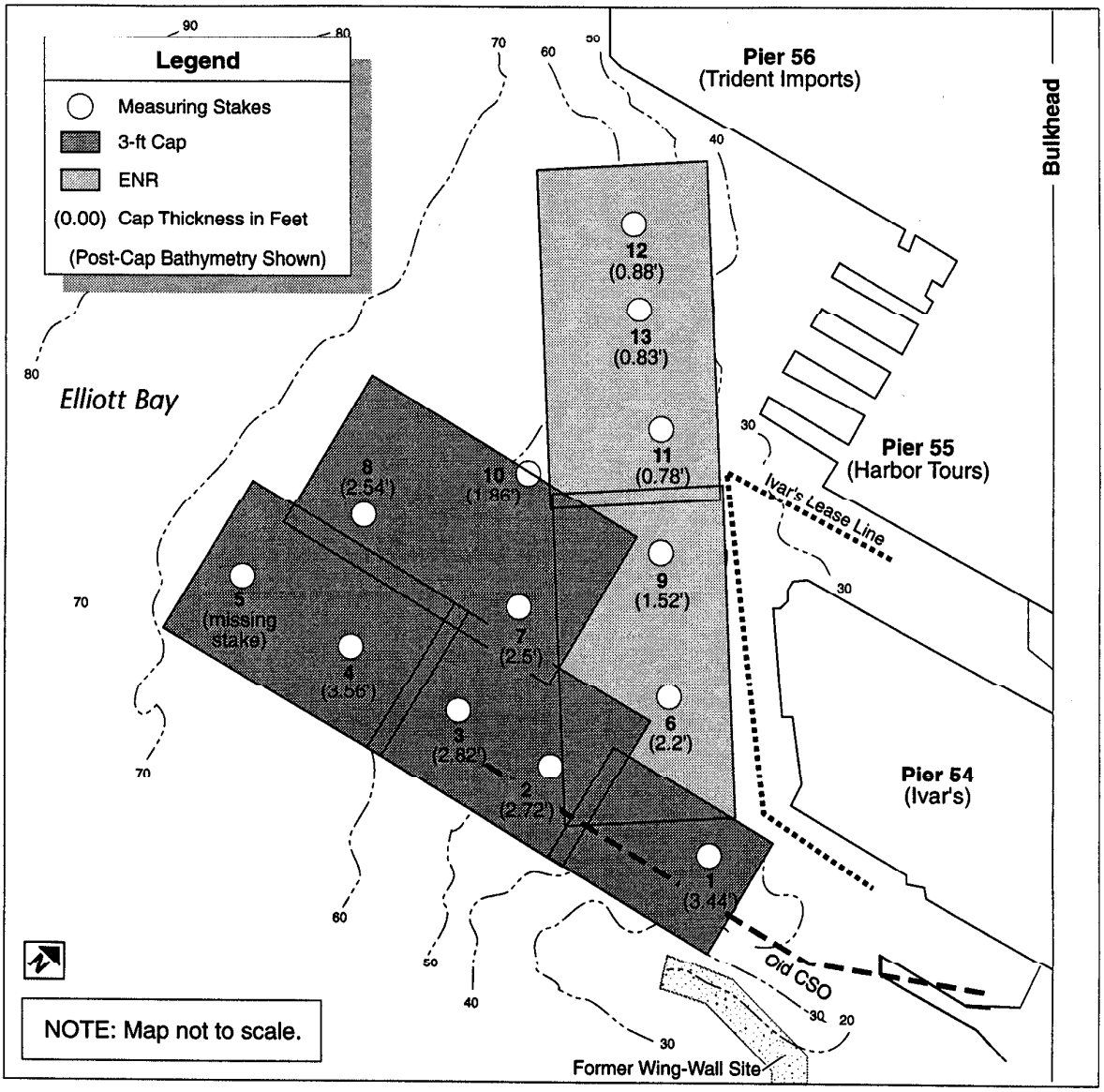

Figure 2-1. Barge Tracks and Measuring Stakes Locations

RESULTS

Cap Thickness

Most of the changes in cap thickness that occurred between cap placement and 1 year later were in the range of a few hundredths of a foot (Table 2-1). Four

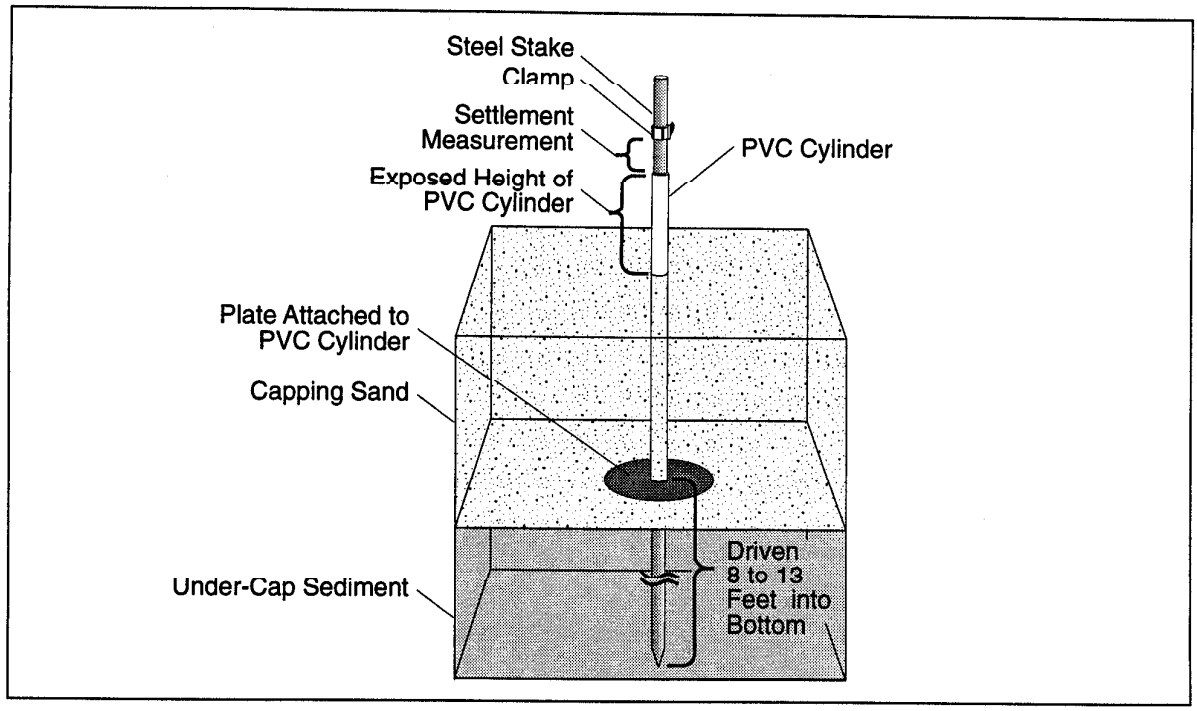

Figure 2-2. Measuring Stake Assembly

measured changes were equal to or slightly greater than 0.1 of a foot (3 cm) and one measurement indicated a change of over 0.5 foot (15 cm).

All of the stakes that were measured along the southern edge of the cap from Stake 1 (inshore) to Stake 4 (offshore) showed at least slight increases in cap thickness, ranging from 0.02 foot (0.61 cm) to 0.5 foot (15 cm). Moving alongshore to the northwest in the ENR (Stakes 6, 9, 11, 13, and 12), two stakes showed that the cap was thinner by 0.12 foot (3.66 cm) and three stakes showed that the cap was thicker ranging from 0.02 foot (0.61 cm) to 0.1 foot (3 cm).

Seafloor Settlement

The overlying burden of 22,000 cubic yards (16,700 m^3) of sand caused some seafloor settlement as anticipated. In the 3-foot cap area, settlement ranged from 0.14 foot (4.25 cm) at Stake 8 to 0.3 foot (9 cm) at Stakes 1 and 4. Settlement measurements were not available at three sites along the southern boundary of the cap because the measuring stakes were damaged or missing. Stake 2 was missing the steel stake (settling assembly remained); Stake 3 was missing the clamp that marks settlement; and Stake 5 was missing completely.

TABLE 2-1. Cap Thicknesses and Settlement at Measuring Stakes (Feet)				
Stake	1992 Cap Thickness	1993 Cap Thickness	Change	Seafloor Settlement
1	2.9	3.44	+ 0.54	0.3
2	2.6	2.72	+ 0.12	Missing steel stake
3	2.8	2.82	+ 0.02	Missing clamp
4	3.5	3.56	+ 0.06	0.3
5	3	Missing stake and assembly		Missing stake and assembly
6	2.1	2.2	+ 0.1	0.2
7	2.5	2.5	0	0.16
8	2.5	2.54	+ 0.04	0.14
9	1.5	1.52	+ 0.02	0.2
10	1.9	1.86	- 0.04	0.04
11	0.9	0.78	- 0.12	0.04
12	1	0.88	- 0.12	0.04
13	0.8	0.83	+ 0.03	0.02

Settlement in the ENR ranged from 0.02 foot (0.61 cm) at Stake 13 to 0.2 foot (6 cm) at Stakes 6 and 9. The ENR settled less than the 3-foot cap, probably because of the smaller amount of overburden.

DISCUSSION

With the exception of Stake 1, all of the changes in cap thickness were less than a few tenths of a foot and most were approximately a few hundredths of a foot. The differences are minor and show that the cap is stable and is isolating the underlying sediments.

Northern Area

The only place cap thickness appeared to decrease was near Stakes 10, 11, and 12 at the northern end of the remediation area and offshore from the Harbor Tours dock. However, Stake 13, located between Stakes 11 and 12, showed some possible increase in thickness. This area should be watched closely for future trends. The decreases are small and possibly reflect minor redistribution of the cap sediment. If significant erosion were occurring it is likely that the entire northern area would be affected.

Visual observations of the surface of the cap also show no indication of erosion. A transect filmed during the diver-held video camera survey (discussed in Section 5 of this report) passed close to Stake 11. The video images of this area showed no ripples or other evidence of bedload transport. The images did show a fine layer of silt and plant material covering the cap. The fine layer was easily

disturbed by the diver. If currents had been strong enough to erode capping sand they would also have washed away this light silty layer.

Southern Area

The southern edge of the cap showed a significant increase in cap thickness (0.5 foot) at the inshore stake and disturbances at several offshore stakes (missing stakes or assembly parts). There were no other such instances of stake disturbances or cap thickness anomalies anywhere else on the cap.

These impacts most likely resulted from pier construction activities at the north side of the downtown Seattle ferry terminal. During the winter of 1992-93, the Washington State Department of Transportation (WSDOT) demolished the auxiliary ferry loading ramp wing wall at the north end of the ferry terminal. Approximately 400 creosote covered piles were removed by crane barge from the subtidal area adjacent to the Pier 53 cap. The crane barge was also used to place riprap rock for stabilizing anchors on the bottom (Romberg, 1993, letter to Ecology). Anchor lines used to moor and move the barges extended out onto the cap and could have damaged the stakes.

The additional 0.5 foot (15 cm) of sediment on the southeast corner of the remediation area could have been caused by a crane barge using a clamshell bucket to dig into the bottom to locate and remove broken piling. Diver observations and an underwater video survey conducted by WSDOT at the former wing-wall site confirm the presence of large holes dug into the bottom by a clamshell bucket. In addition, bathymetry of the wing-wall area shows that the southeast corner of the cap, where Stake 1 is located, is downgradient of the wing wall and at the end of a valley-like depression. Sediment that was stirred up during the demolition of the wing wall would tend to funnel down the depression before settling.

SECTION 3

CORE CHEMISTRY

On May 18 and 19, 1993, the monitoring team collected core samples from the 3-foot cap and ENR. The samples were collected and analyzed to determine whether contaminants are migrating from under-cap sediments upward into the cap. Core samples were analyzed for trace metal, organic, and conventional parameters. This section describes the core sampling methods and compares the chemistry of the cap to that of the under-cap sediments and compares both cap and under-cap chemistry to the SMS and to the 1992 baseline results.

METHODS

The monitoring plan defined five core sampling stations (C1 through C5), as shown in Figure 3-1. Two stations are in the ENR (C4 and C5), and three stations are in the 3-foot cap (C1, C2, and C3) to allow comparisons between the two areas. The stations are located in water depths of 55 to 60 feet (16.6 to 18 m) and in areas where the bottom slope is less steep than farther inshore. C1 is located in the southeast corner of the site where some of the highest chemical levels were previously observed and where sampling is more likely to detect the possible upward migration of contaminants into the cap. All five stations are situated at least 30 feet (9 m) away from the surface sampling stations so that any potential release of contaminated sediment from core sampling activities would not affect surface samples. Baseline core samples were collected from all five stations in May 1992.

Sample Collection

During the 1993 sampling, two cores were collected from each of the five stations. The longest core was analyzed first, while the second served as a backup in case there was a problem with the first core.

The monitoring team consisted of a diver, a diving support crew and boat, Metro's *RV Liberty* and crew, and a shore-based survey crew. The *RV Liberty* crew began by setting marker buoys at each coring station. The shore-based survey crew guided the *RV Liberty* to the stations using a range azimuth laser positioning system.

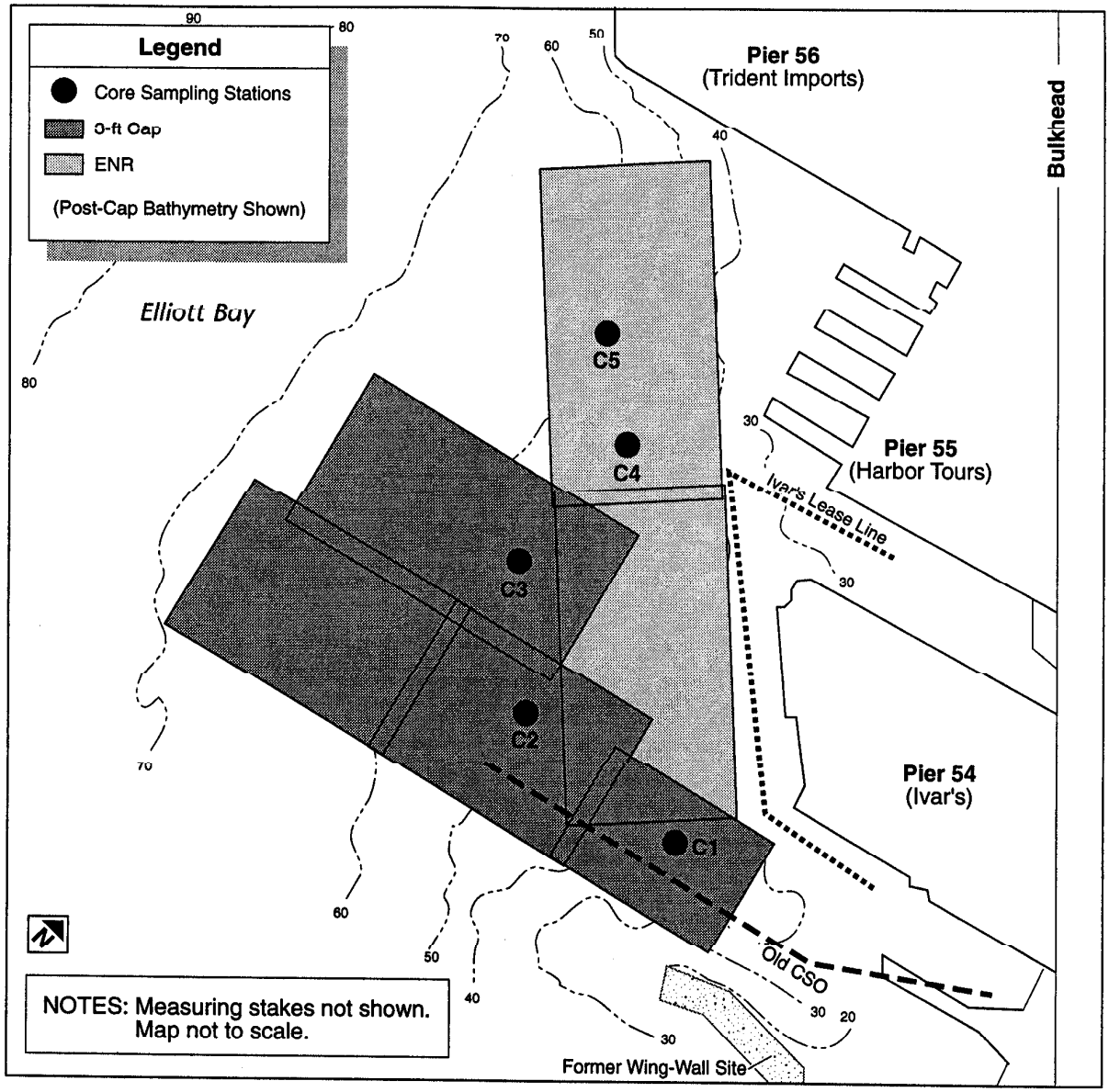

Figure 3-1. Core Sampling Stations

After the buoys were set, the *RV Liberty* crew anchored at a coring station and tied the diver support boat alongside. The diver carried a 6-foot-long (1.8 m), 4-inch-diameter (10 cm), thin-walled aluminum coring tube into the water and down to the core station and inserted it into the bottom, keeping it vertical. While in the water, the diver was in constant contact with the support boats via closed-circuit radio. A 0.5-inch nylon rope was attached from a boat winch to the

coring tube for later retrieval of the core. The crew, using another winch, lowered a pneumatic jackhammer to the diver. The diver then jackhammered the core tube through the cap and into the sediments below. The diver required about 10 minutes to drive the core tube 5 feet (1.5 m) into the bottom, leaving about 1 foot (30 cm) of the core tube above the bottom. Each core extended completely through the cap and into the underlying contaminated sediments by at least 1 foot. Once the core tube was deep enough, the diver removed the jackhammer and inserted a rubber screw plug into the top of the tube. The winch operator, using the nylon rope attached to the coring tube, slowly pulled the core out of the bottom sediments. Once the core was free of the bottom, the diver inserted a second rubber screw plug into the bottom of the tube to completely encapsulate the sample.

The core samples were then brought onboard where the top plug was removed, excess water was siphoned off, and the length of the core was measured. Each core tube was labeled with a permanent marker to show station number and the length of the core sample. The cores were transported to Metro's laboratory and stored in a walk-in freezer.

Sample Analysis

Shortly before the cores were processed, they were removed from the freezer and the aluminum tubes were cut down the sides lengthwise. Half of the tube was removed and the other half was left to hold the core. The core was then placed under a heat lamp to thaw.

When a core was thawed, it was divided into 6-inch-long (15 cm) sections for analysis, as shown in Figure 3-2. In the cores taken from the 3-foot cap area, one 6-inch section was taken below the interface of the cap with the contaminated sediment and four 6-inch sections were taken from above the interface (within the cap). In cores taken from the ENR area, one 6-inch section was taken from below the interface and two 6-inch sections were taken from within the cap. Before the sections were cut, a 1-inch-thick (2.5 cm) band of cap sediment above the interface was discarded to remove any contaminated sediment that may have been mixed into the cap during placement. The outsides of the 6-inch sections were scraped away, and the interior of the core was scooped out and placed into a beaker. The material in each beaker was stirred before a sample was taken for analysis.

Because analysis of the core sections in 1992 showed that there was no migration of contaminants into the cap, the decision was made to analyze only

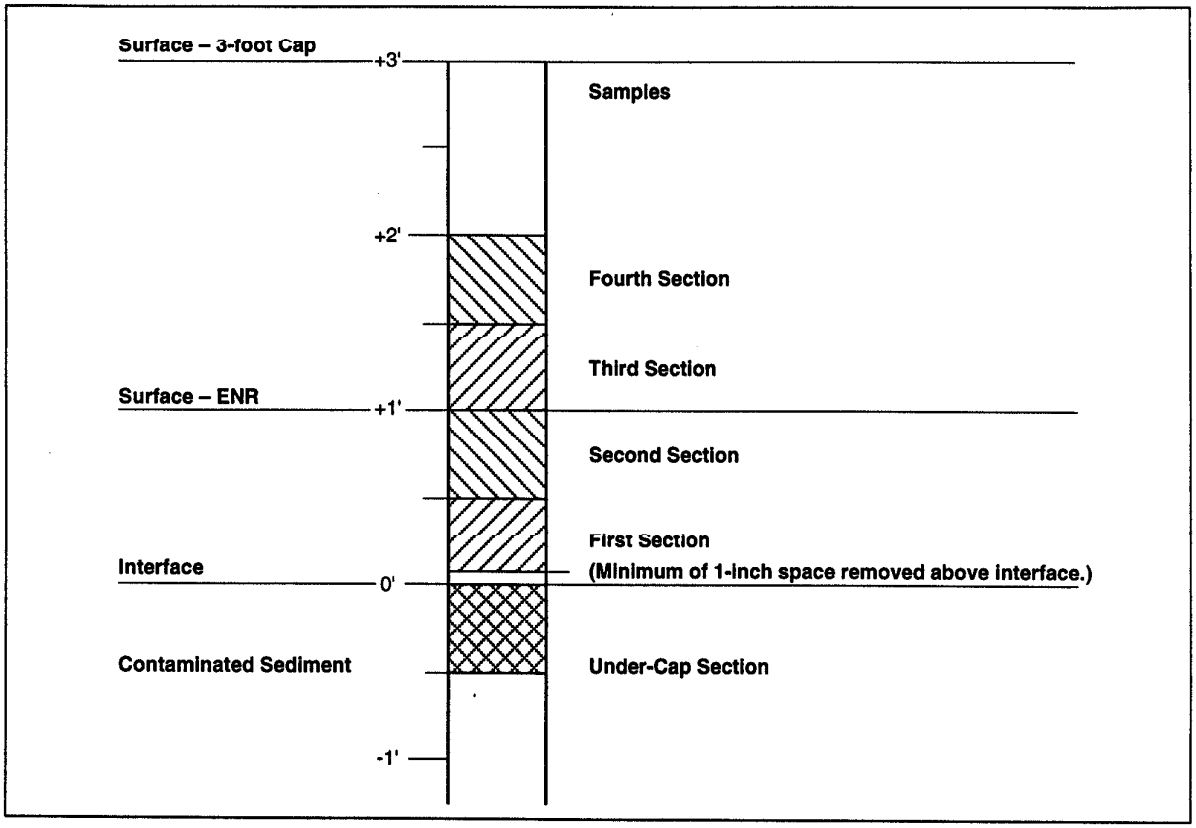

Figure 3-2. Cross Section of Core Sample

two 6-inch sections of each core: the sections directly below ("under cap") and above ("first 6-inch section") the interface of the cap and the contaminated sediments. If migration were to occur, the chemicals would be found in the first 6-inch section. The only exception was C4 (in the ENR). The core taken from this station in 1992 showed higher concentrations in the first 6-inch section than other within cap sections. These higher concentrations were probably caused by the presence of clay in the core sample. The clay was dredged along with the capping sands from the Duwamish River. However, to increase sample coverage at this station and to possibly establish whether migration is taking place, the sample from the second 6-inch section was also analyzed. In addition, a replicate core was analyzed at C2 to compare sampling variability.

Metro's Environmental Laboratory analyzed the samples for trace metals, base neutral acid extractable (BNA) organics, pesticides, and polychlorinated biphenyls (PCBs). BNAs include low and high molecular weight polycyclic aromatic hydrocarbons (LPAHs and HPAHs). The lab used the EPA and Puget

Sound Environmental Program approved procedures for sediment analysis. (Quality assurance procedures are discussed in Appendix B.) AmTest, Inc., analyzed the samples for conventional parameters, including particle size distribution, total solids, and total organic carbon. Certain BNA organics and PCBs were normalized with respect to total organic carbon for comparison to the SQS and CSL. These values were reported as milligrams per kilogram (mg/kg) organic carbon.

RESULTS

Data tables and figures appear at the end of this section. Data tables show detected chemicals on a dry-weight basis (Tables 3-1 through 3-6), comparisons to the SMS (Tables 3-7 through 3-9), and particle size distribution (Table 3-10 through 3-12). Figures show comparisons of chemical concentrations between the undercap, first 6-inch section, and the cap surface (Figures 3-3 through 3-7). A complete list and explanation of qualifiers also appears in Appendix B.

Analysis of the 1993 core samples indicated that chemicals from the underlying sediments have not migrated up into the 3-foot cap or ENR. The samples showed a dramatic contrast between the high chemical concentrations of the under-cap sediments and the low or undetected concentrations in the cap. Of the 99 organic compounds analyzed for, only 8 were detected in all of the first 6-inch sections from the cap compared to 27 detected under the cap. Of the 15 metals analyzed for, 10 were detected in the first 6-inch sections of the cap compared to 13 detected under the cap. Concentrations of organics and metals found in the first 6-inch sections of the cap were low and never approached the SQS. Concentrations were much higher under the cap where many organic compounds and metals exceeded the SQS and CSL.

Particle size distribution showed the expected dissimilarities between the under-cap samples and the within-cap samples. All within-cap samples were over 90 percent sands ranging from 92 percent sands at C3 to 97 percent sands in the C2 replicate. The under-cap samples had a much higher percentage of silts and clays, ranging from 72 percent silts and clays at C4 to 59 percent silts and clays at C5. For three under-cap samples there was insufficient sediment volume to permit a particle size analysis. The three samples, however, had total solids percentages that were similar to the other under-cap samples, which indicates that all the under-cap samples have similar particle size composition.

First 6-Inch Sections of the Cap and ENR

Organics. Eight organic compounds were detected in the first 6-inch sections: five HPAHs, one LPAH, benzoic acid, and one pesticide. The pesticide, Aldrin, was detected in trace amounts at C5. No PCBs were detected. Three organic compounds were detected at C1, two were detected in the C2 replicate sample, one was detected in the C2 primary sample, and six were detected in each of the samples taken at C3, C4, and C5. Fluoranthene was the most common organic compound and was detected at all stations, ranging in concentrations from 68 µg/kg dry weight at C3 to below the reporting detection limit (RDL) in both the C2 primary and replicate samples.

Metals. Metal concentrations also were low; mercury ranged from 0.02 to 0.04 mg/kg dry weight, silver was undetected, lead was below the RDL, and zinc ranged between 45 and 59 mg/kg dry weight.

Under-Cap Sections

Organics. Twenty-seven organic compounds were detected in the under-cap samples. The sample at C5 showed the lowest concentrations of all the core stations, while the replicate sample at C2 showed the highest concentrations. Phenanthrene, pyrene, benzo(b)fluoranthene, and chrysene were found in the highest dry-weight concentrations, ranging from 9,500 µg/kg for fluoranthene in the C2 replicate to 750 µg/kg for phenanthrene at C5. Total dry-weight LPAH concentrations ranged from 1,600 µg/kg at C5 to 13,000 µg/kg in the C2 replicate. Total dry-weight HPAH concentrations ranged from 6,700 µg/kg at C5 to 42,000 µg/kg in the C2 replicate. 2,4-dimethylphenol exceeded the CSL in the C2 replicate, but was undetected in all other samples. Total organic carbon was 12 percent for the C2 replicate compared to an under-cap average of 5 percent.

PCBs were detected in C1, C2, C2 replicate, and C5. The PCBs detected were Aroclor 1248, 1254, and 1260. Aroclor 1254 and 1260 were found most often, and Aroclor 1254 was generally found in the highest concentrations. The concentrations of total PCBs exceeded the SQS at C1 and the primary core at C2, and they exceeded the CSL in the C2 replicate.

Metals. The under-cap samples also showed elevated metal concentrations especially at C1, C2 and C3. In six samples, metals exceeded the SQS 22 times and 20 of these exceeded the CSL. Mercury exceeded the CSL in all under-cap samples, and silver exceeded the CSL in four of these. The C2 replicate showed the highest concentrations of metals, with mercury, cadmium, chromium, copper, lead, silver, and zinc all exceeding the CSL.

Second 6-Inch Section at C4

The second 6-inch section at C4 showed elevated levels of organics and metals and many detected parameters in comparison to other within-cap sections. Fifteen organic compounds were detected in this sample, ranging in concentration from 1,500 µg/kg dry weight for fluoranthene to 30 µg/kg dry weight for acenaphthylene.

The analysis indicated that the elevated levels were not caused by chemical migration up into the cap. Laboratory core cutting logs showed that this section contained cap surface material, which showed elevated concentrations (Section 4). In addition, the first 6-inch section showed much lower concentrations than the second 6-inch section. If migration were occurring, concentrations in the first 6-inch section would be as high or higher than the second 6-inch section.

The second 6-inch section was not tested for total organic carbon content because of a clerical error. The sample was therefore not included in the tables that compare the chemistry values to the SMS. Substituting an estimated value of 2 percent organic carbon shows that when normalized with respect to total organic carbon no organics exceeded either the SQS or CSL. Also, no dry weight organics or metals exceeded either the SQS or CSL.

DISCUSSION

Comparison to the 1992 Baseline Data

First 6-Inch Sections. Chemical composition of the first 6-inch core sections collected in 1992 were very similar to the those collected in 1993. Organic chemical comparisons are as follows:

- Eight organic compounds were detected in all the first 6-inch sections in 1993 compared to 10 in the 1992 baseline study.

- Detected concentrations in 1993 ranged from below the RDL for several compounds in four samples to 68 µg/kg dry weight for fluoranthene at C3. This compares to concentrations in 1992 that ranged from 29 µg/kg dry weight for benzo(a)anthracene at C3 to 470 µg/kg dry weight for benzo(a)anthracene at C4.

- The greater number of detected chemicals and higher concentrations in the 1992 samples were attributed to clay from the Duwamish River in the first 6-inch section at C4.

With the exception of the first 6-inch section of C4 in 1992, metals were found in low concentrations at all stations in both 1992 and 1993. Metal comparisons are as follows:

- Cadmium, mercury, and silver were either undetected or found in concentrations close to the detection limits in both years.

- Copper ranged from 15 to 18 mg/kg dry weight in 1993 and 9.4 to 12 mg/kg dry weight in 1992.

- Zinc ranged from 45 to 59 mg/kg dry weight in 1993 and 39 to 42 mg/kg dry weight in 1992.

Under-Cap Sections. The 1993 under-cap concentrations showed many differences when compared to those in 1992. Generally, in 1993 the concentrations were higher and more parameters exceeded the CSL. Comparison of organic concentrations in µg/kg dry weight are as follows:

- Total LPAHs in five of the six below-cap samples ranged from almost 60 percent to 300 percent higher in 1993 than in 1992.

- Total HPAH differences were less significant. Three 1993 samples were similar (within 10 percent of the 1992 values), and three other 1993 samples ranged from 33 to 60 percent higher than in 1992.

Metals exceeded the CSL in 20 cases in the 1993 samples compared to 8 in 1992. Comparison of metal concentrations in mg/kg dry weight are as follows:

- Mercury in 1993 was higher in two samples, similar (within 10 percent) in two samples, and lower in two samples than in 1992. Mercury was 4 times higher in the 1993 C2 replicate sample than in the 1992 C2 regular sample.

- Lead was higher in all six 1993 samples than in 1992, ranging from 35 percent to 2.5 times higher.

- Silver was higher in four 1993 samples than in 1992, ranging from almost 60 percent to over 1,000 percent higher. Silver was lower in two 1993 samples, by 200 percent at C4 and by 30 percent at C5.

Comparison of C2 to the C2 Replicate

The C2 replicate sample was taken to compare core sampling variability.

First 6-Inch Sections. Organic compounds and metals were nearly identical in the first 6-inch sections of the cap in the C2 replicate and the C2 primary samples. Fluoranthene and pyrene were the only organic compounds detected in the replicate sample, and pyrene was the only compound detected in the primary sample. The compounds were detected below the RDL in both samples. Mercury and lead were at or below detection limits. Cadmium and silver were below detection limits. All other concentrations of detected metals were different only by approximately 10 to 15 percent.

Under-Cap Sections. A comparison of the under-cap C2 primary and replicate samples shows significant differences in concentrations. Both total LPAHs and total HPAHs were nearly 100 percent higher in the replicate sample. Metal concentrations were also higher in the C2 replicate sample. Mercury, silver, and zinc were over 100 percent higher; chromium and cadmium were over 400-percent higher; copper was over 300 percent higher; and lead was close to 100-percent higher in the replicate sample.

Possible Explanations for Variations in Under-Cap Results

It is not clear why the differences were so great between the under-cap sections of the C2 primary and C2 replicate samples or between the under-cap samples taken in 1992 and in 1993. Pre-cap samples and 1992 baseline under-cap samples all showed the C2 core location to have high metal concentrations, but 1993 concentrations even exceed these previous concentrations. In the case of the 1993 C2 replicate, many concentrations of metals are 2 to 15 times higher than those in the 1992 C2 under-cap sample. While most metal concentrations increased, iron and aluminum, which are good indicators of sediment type, remained largely unchanged. The uniformity of iron and aluminum values indicates that laboratory analysis and procedures were consistent between the sampling events. Unexpected differences also occurred in the under-cap core samples during periodic monitoring at the Denny Way sediment cap, where concentrations in the years following the baseline study showed lower values than expected (Metro, 1994).

Possible explanations include the variability of the contaminant concentrations under the cap and the variability of sampling procedures. C2 is near the end of the former CSO outfall pipe, which could have caused contaminant concentrations in the sediment to vary in this area. Slightly different locations of all cores could account for the differences in concentrations. Or perhaps the 1993 C2 under-cap replicate contained a fragment of metal alloy. Another possibility is that core sampling procedures may have caused the sampler to capture deeper and more contaminated sediments. The core tubes are driven through the sediment cap and then continue into the softer, native muds below. The sand-filled core tube could have forced aside the upper, less contaminated layer of mud before capturing deeper and more contaminated mud.

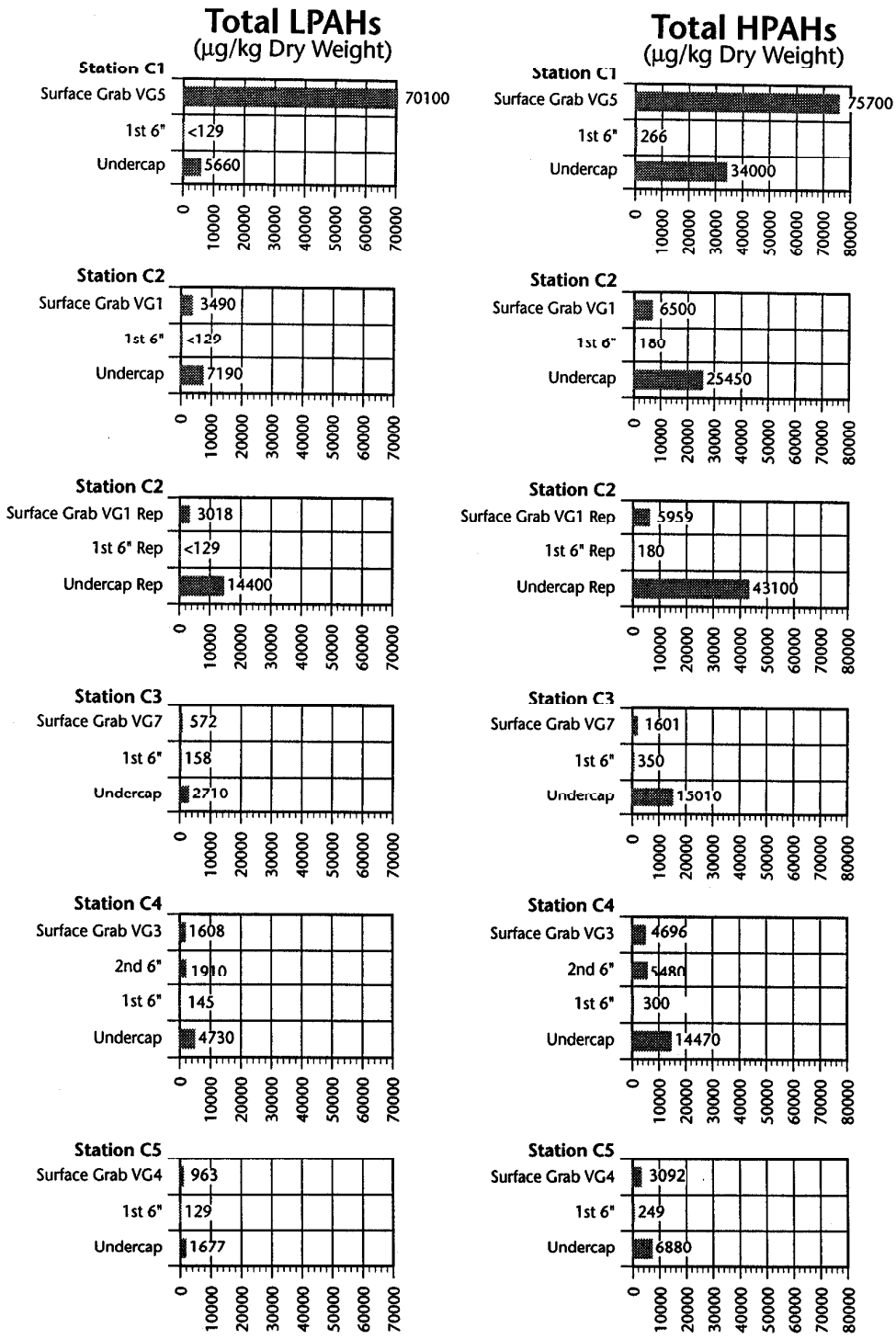

Figure 3-3. Total LPAH and Total HPAH

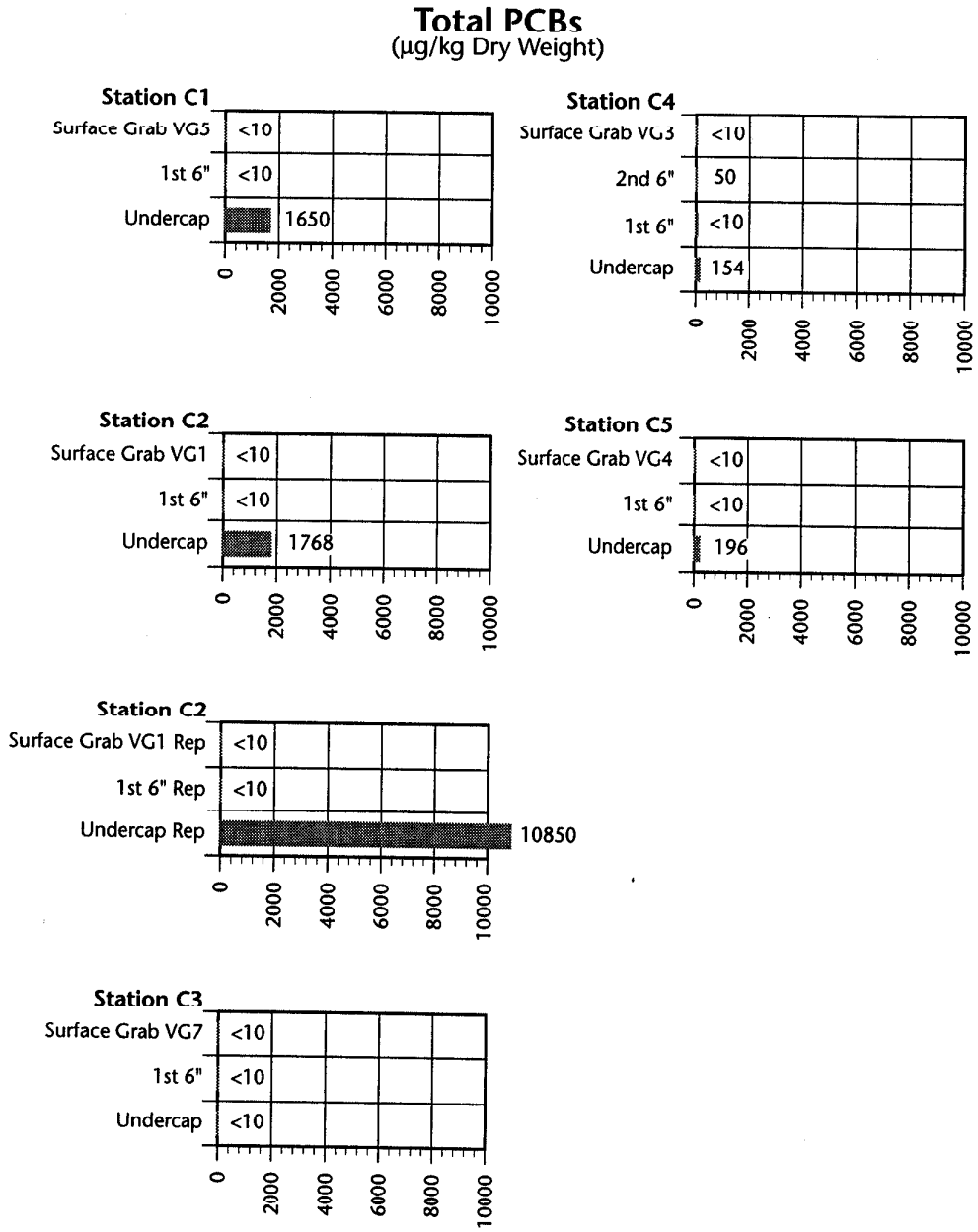

Figure 3-4. Total PCBs

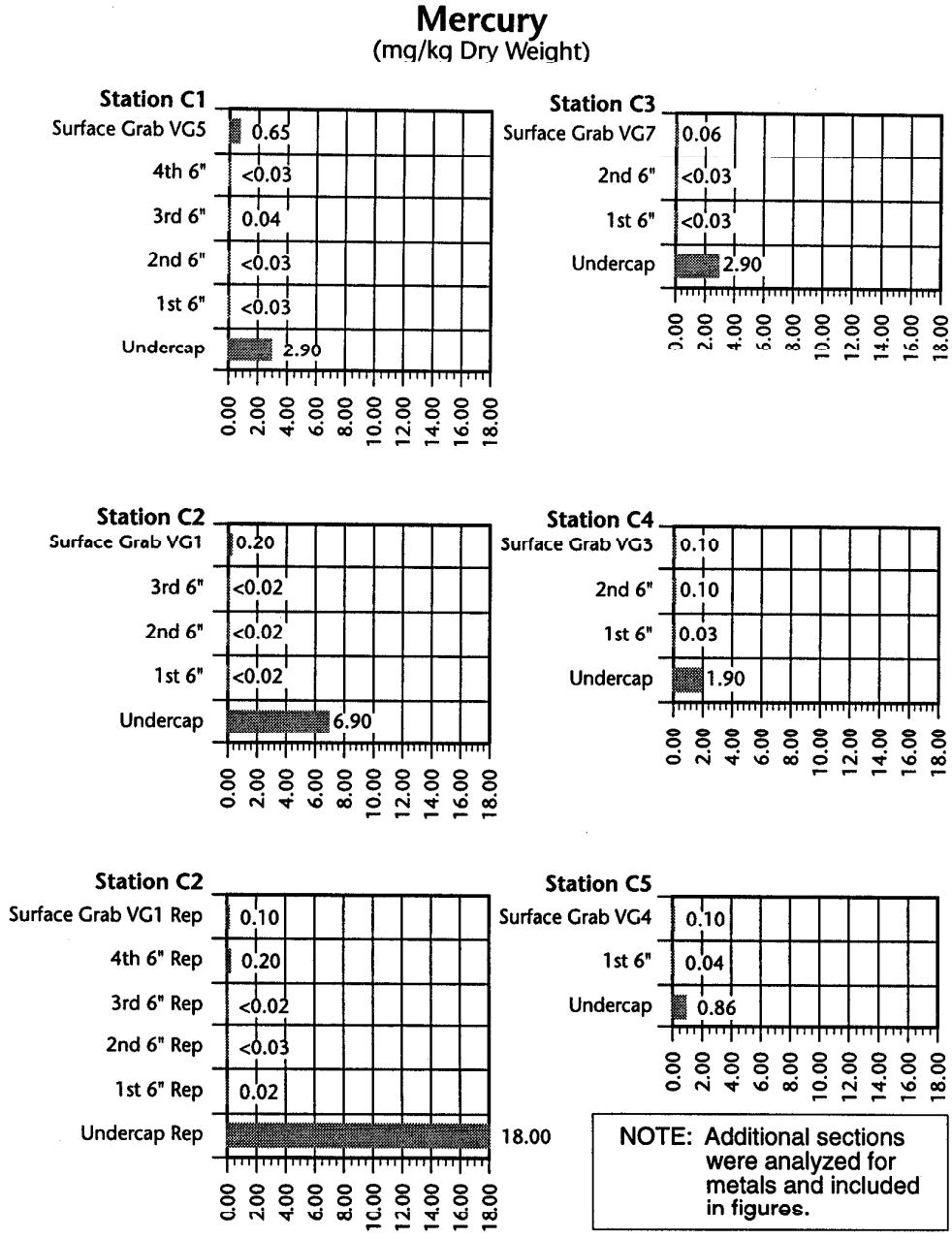

Figure 3-5. Mercury

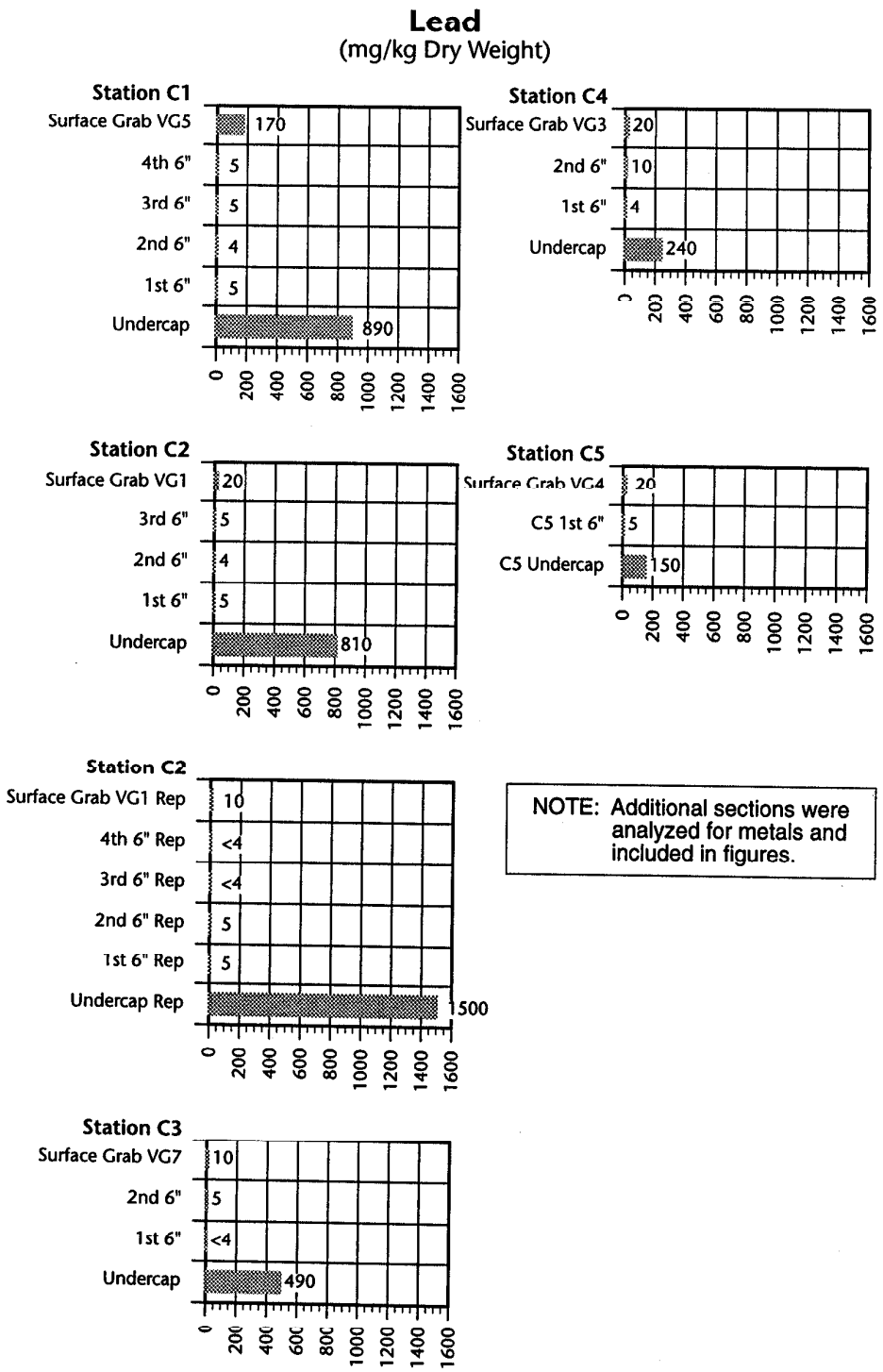

Figure 3-6. Lead

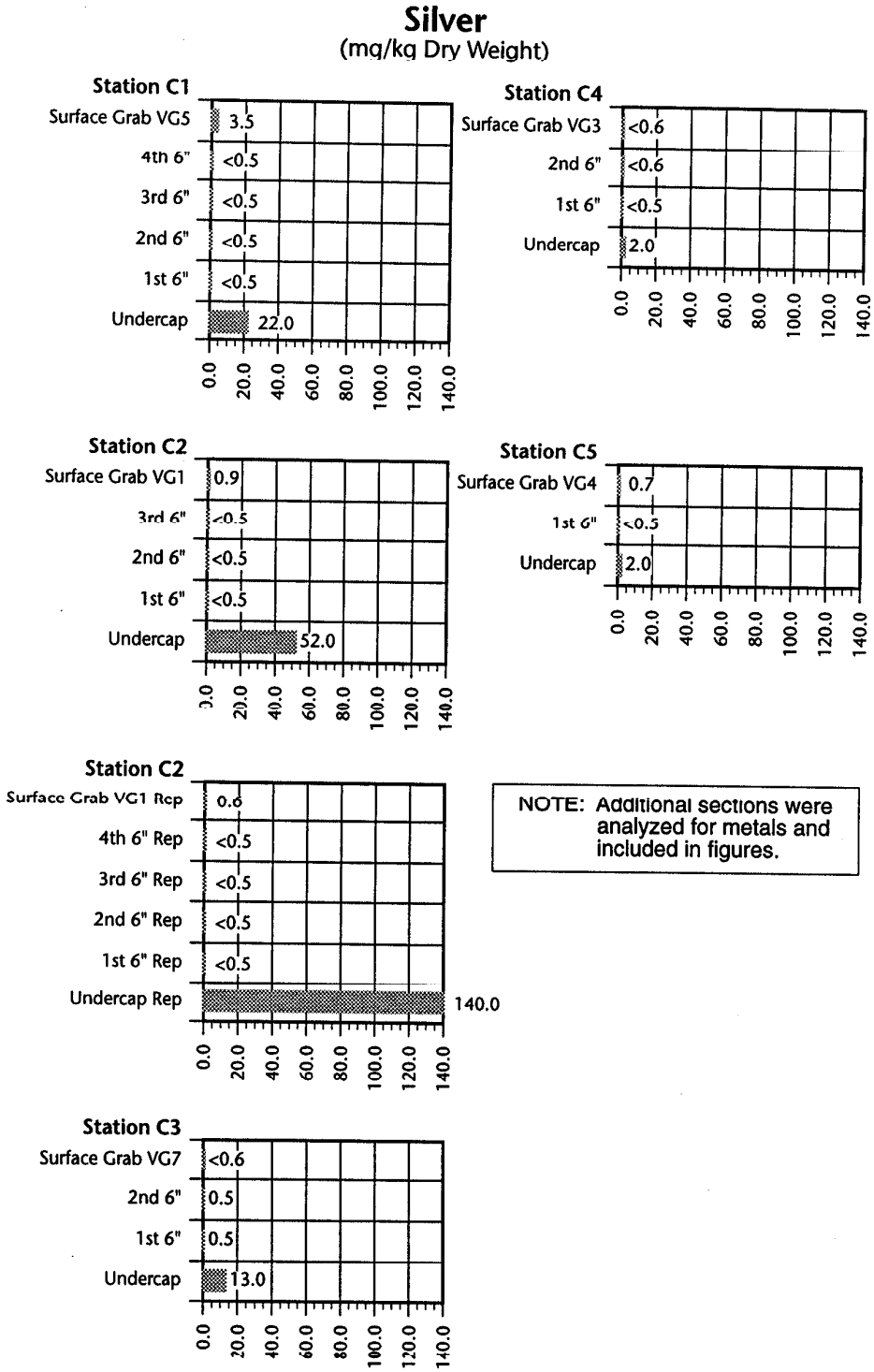

Figure 3-7. Silver

TABLE 3-1. Core C1, Detected Chemicals

Station/Section	C1 Undercap				C1 1st 6"			
Date	May 18, 93				May 18, 93			
Sample Number	L1211-1				L1211-2			
% Solids	55				78			
% Total Organic Carbon	6.9				1.5			
BNA Organics (µg/kg dry weight)	**Value**	**Qual**	**MDL**	**RDL**	**Value**	**Qual**	**MDL**	**RDL**
LPAHs								
Naphthalene	360		90	180		<MDL	40	63
Acenaphthylene	400		40	60		<MDL	10	21
Acenaphthene	310		20	49		<MDL	9	17
Fluorene	510		40	60		<MDL	10	21
Phenanthrene	2700		40	60		<MDL	10	21
Anthracene	1200		40	60		<MDL	10	21
2-Methylnaphthalene	180	<RDL	90	180		<MDL	40	63
Total LPAHs	5660				129			
HPAHs								
Fluoranthene	3100		40	73	45		10	26
Pyrene	5800		40	60	31		10	21
Benzo(a)anthracene	3300		40	60		<MDL	10	21
Chrysene	4500		40	60	10	<RDL	10	21
Benzo(k)fluoranthene	3100		90	180		<MDL	40	63
Benzo(b)fluoranthene	7800		90	180		<MDL	40	63
Benzo(a)pyrene	4000		50	120		<MDL	30	42
Benzo(g,h,i)perylene	1100		50	120		<MDL	30	42
Indeno(1,2,3-Cd)Pyrene	1300		50	120		<MDL	30	42
Dibenzo(a,h)anthracene		<MDL	90	180		<MDL	40	63
Total HPAHs	34090				306			
Other BNAs								
Dibenzofuran	330		50	120		<MDL	30	42
Carbazole	420		50	120		<MDL	30	42
2,4-Dimethylphenol		<MDL	50	120		<MDL	30	42
4-Methylphenol		<MDL	50	120		<MDL	30	42
Benzyl Butyl Phthalate		<MDL	40	60		<MDL	10	21
Benzoic Acid		<MDL	200	360		<MDL	90	130
Pesticides and PCBs (µg/kg dry weight)								
4,4'-DDD		<MDL	50	120		<MDL	1	2.2
Aldrin		<MDL	50	120		<MDL	1	2.2
Aroclor 1248	290		76	150		<MDL	10	22
Aroclor 1254	690		76	150		<MDL	10	22
Aroclor 1260	670		76	150		<MDL	10	22
Metals (mg/kg dry weight)								
Mercury	2.9	G	0.04	0.36		<MDL,G	0.03	0.26
Aluminum	25000		20	91	13000		10	64
Antimony		<MDL,G	9	49		<MDL,G	5	24
Arsenic	40	<RDL	9	45	9	<RDL	6	32
Beryllium	0.9	<RDL	0.2	0.91	0.5	<RDL	0.1	0.64
Cadmium	11		0.9	4.9		<MDL	0.4	1.9
Chromium	100		0.9	4.5	17		0.6	3.2
Copper	360		1	6.5	18		0.6	3.3
Iron	35000		9	45	24000		6	32
Lead	890		9	49	5	<RDL	4	19
Nickel	47		4	18	15		3	13
Selenium		<MDL	9	45		<MDL	6	32
Silver	22		1	6.5		<MDL	0.5	2.6
Thallium		<MDL	40	180		<MDL	30	130
Zinc	380		0.9	4.5	59		0.6	3.2

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limits
B - Blank contamination
E - Estimate
G - Low standard reference material recovery
L - High standard reference material recovery

Note: For further information on data qualifiers see Appendix B.

TABLE 3-2. Core C2, Detected Chemicals

Station/Section	C2 Undercap				C2 1st 6"			
Date	May 18, 93				May 18, 93			
Sample Number	L1211-6				L1211-7			
% Solids	54				81			
% Total Organic Carbon	7.2				0.12			
BNA Organics (µg/kg dry weight)	**Value**	**Qual**	**MDL**	**RDL**	**Value**	**Qual**	**MDL**	**RDL**
LPAHs								
Naphthalene	310		90	190		<MDL	40	62
Acenaphthylene	260		40	61		<MDL	10	21
Acenaphthene	500		20	50		<MDL	9	16
Fluorene	540		40	61		<MDL	10	21
Phenanthrene	4400		40	61		<MDL	10	21
Anthracene	940		40	61		<MDL	10	21
2-Methylnaphthalene	240		90	190		<MDL	40	62
Total LPAHs	7190				129			
HPAHs								
Fluoranthene	3000		40	74	10	<RDL	10	25
Pyrene	4300		40	61		<MDL	10	21
Benzo(a)anthracene	3100		40	61		<MDL	10	21
Chrysene	3500		40	61		<MDL	10	21
Benzo(k)fluoranthene	2600		90	190		<MDL	40	62
Benzo(b)fluoranthene	3900		90	190		<MDL	40	62
Benzo(a)pyrene	3000		60	120		<MDL	20	41
Benzo(g,h,i)perylene	850		60	120		<MDL	20	41
Indeno(1,2,3-Cd)Pyrene	1200		60	120		<MDL	20	41
Dibenzo(a,h)anthracene	370		90	190		<MDL	40	62
Total HPAHs	25820				220			
Other BNAs								
Dibenzofuran	260		60	120		<MDL	20	41
Carbazole	460		60	120		<MDL	20	41
2,4-Dimethylphenol		<MDL	60	120		<MDL	20	41
4-Methylphenol	300		60	120		<MDL	20	41
Benzyl Butyl Phthalate	240		40	61		<MDL	10	21
Benzoic Acid		<MDL	200	370		<MDL	90	120
Pesticides and PCBs (µg/kg dry weight)								
4,4'-DDD	120		60	98		<MDL	1	2.1
Aldrin		<MDL	60	98		<MDL	1	2.1
Aroclor 1248		<MDL	78	150		<MDL	10	21
Aroclor 1254	1100		78	150		<MDL	10	21
Aroclor 1260	590		78	150		<MDL	10	21
Metals (mg/kg dry weight)								
Mercury	6.9	G	0.2	1.9		<MDL,G	0.02	0.25
Aluminum	20000		20	85	10000		10	57
Antimony	10	<RDL,G	10	48		<MDL,G	5	21
Arsenic	40	<RDL	9	43	10	<RDL	6	28
Beryllium	0.7	<RDL	0.2	0.85	0.4	<RDL	0.1	0.57
Cadmium	16		1	4.8		<MDL	0.4	1.7
Chromium	98		0.9	4.3	17		0.6	2.8
Copper	480		1	6.5	17		0.6	2.8
Iron	28000		9	43	21000		6	28
Lead	810		10	48	5	<RDL	4	17
Nickel	43		4	17	17		2	11
Selenium		<MDL	9	43		<MDL	6	28
Silver	52		1	6.5		<MDL	0.5	2.3
Thallium		<MDL	40	170		<MDL	20	110
Zinc	670		0.9	4.3	52		0.6	2.8

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limits
B - Blank contamination
E - Estimate
G - Low standard reference material recovery
L - High standard reference material recovery

Note: For further information on data qualifiers see Appendix B.

TABLE 3-3. Core C2 Replicate, Detected Chemicals

Station/Section	C2 Undercap Replicate				C2 1st 6" Replicate			
Date	May 18, 93				May 18, 93			
Sample Number	L1211-11				L1211-12			
% Solids	41				82			
% Total Organic Carbon	12				0.6			
BNA Organics (µg/kg dry weight)	**Value**	**Qual**	**MDL**	**RDL**	**Value**	**Qual**	**MDL**	**RDL**
LPAHs								
Naphthalene		<MDL	700	1200		<MDL	40	61
Acenaphthylene		<MDL	200	410		<MDL	10	21
Acenaphthene	1000		200	320		<MDL	9	16
Fluorene	900		200	410		<MDL	10	21
Phenanthrene	8500		200	410		<MDL	10	21
Anthracene	2400		200	410		<MDL	10	21
2-Methylnaphthalene		<MDL	700	1200		<MDL	40	61
Total LPAHs	14400				129			
HPAHs								
Fluoranthene	9500		200	490	10	<RDL	10	24
Pyrene	8300		200	410	10	<RDL	10	21
Benzo(a)anthracene	4900		200	410		<MDL	10	21
Chrysene	5900		200	410		<MDL	10	21
Benzo(k)fluoranthene	3200		700	1200		<MDL	40	61
Benzo(b)fluoranthene	5100		700	1200		<MDL	40	61
Benzo(a)pyrene	3200		500	800		<MDL	20	40
Benzo(g,h,i)perylene	1200		500	800		<MDL	20	40
Indeno(1,2,3-Cd)Pyrene	1800		500	800		<MDL	20	40
Dibenzo(a,h)anthracene		<MDL	700	1200		<MDL	40	61
Total HPAHs	43800				220			
Other BNAs								
Dibenzofuran		<MDL	500	800		<MDL	20	40
Carbazole		<MDL	500	800		<MDL	20	40
2,4-Dimethylphenol	4400		500	800		<MDL	20	40
4-Methylphenol		<MDL	500	800		<MDL	20	40
Benzyl Butyl Phthalate		<MDL	200	410		<MDL	10	21
Benzoic Acid		<MDL	2000	2400		<MDL	90	120
Pesticides and PCBs (µg/kg dry weight)								
4,4'-DDD	800		200	490		<MDL	1	2.1
Aldrin		<MDL	200	490		<MDL	1	2.1
Aroclor 1248		<MDL	150	320		<MDL	10	21
Aroclor 1254	8000		150	320		<MDL	10	21
Aroclor 1260	2700		150	320		<MDL	10	21
Metals (mg/kg dry weight)								
Mercury	18	G	0.5	4.9	0.02	<RDL,G	0.02	0.24
Aluminum	13000		20	110	9600		10	57
Antimony	20	<RDL,G	20	83		<MDL,G	5	21
Arsenic	20	<RDL	10	59	7	<RDL	6	29
Beryllium	0.5	<RDL	0.2	1.1	0.4	<RDL	0.1	0.57
Cadmium	100		2	8.3		<MDL	0.4	1.7
Chromium	510		1	5.9	13		0.6	2.9
Copper	2200		2	11	15		0.6	2.8
Iron	21000		10	59	18000		6	29
Lead	1500		20	83	5	<RDL	4	17
Nickel	71		5	23	13		2	11
Selenium		<MDL	10	59		<MDL	6	29
Silver	140		2	11		<MDL	0.5	2.3
Thallium		<MDL	50	230		<MDL	20	110
Zinc	1400		1	5.9	45		0.6	2.9

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limits
B - Blank contamination
E - Estimate
G - Low standard reference material recovery
L - High standard reference material recovery

For further information on data qualifiers see Appendix B.

TABLE 3-4. Core C3, Detected Chemicals

Station/Section	C3 Undercap				C3 1st 6"			
Date	May 19, 93				May 19, 93			
Sample Number	L1211-16				L1211-17			
% Solids	55				79			
% Total Organic Carbon	5.1				0.78			
BNA Organics (µg/kg dry weight)	Value	Qual	MDL	RDL	Value	Qual	MDL	RDL
LPAHs								
Naphthalene		<MDL	90	180		<MDL	40	63
Acenaphthylene	220		40	60		<MDL	10	22
Acenaphthene	140		20	49		<MDL	9	16
Fluorene	220		40	60		<MDL	10	22
Phenanthrene	1300		40	60	39		10	22
Anthracene	650		40	60		<MDL	10	22
2-Methylnaphthalene	90	<RDL	90	180		<MDL	40	63
Total LPAHs	2710				158			
HPAHs								
Fluoranthene	1200		40	73	68		10	25
Pyrene	3100		40	60	53		10	22
Benzo(a)anthracene	1300		40	60	29		10	22
Chrysene	1700		40	60	30		10	22
Benzo(k)fluoranthene	1500		90	180		<MDL	40	63
Benzo(b)fluoranthene	3100		90	180	40	<RDL	40	63
Benzo(a)pyrene	1800		50	120		<MDL	30	42
Benzo(g,h,i)perylene	530		50	120		<MDL	30	42
Indeno(1,2,3-Cd)Pyrene	780		50	120		<MDL	30	42
Dibenzo(a,h)anthracene		<MDL	90	180		<MDL	40	63
Total HPAHs	15100				390			
Other BNAs								
Dibenzofuran	160		50	120		<MDL	30	42
Carbazole	270		50	120		<MDL	30	42
2,4-Dimethylphenol		<MDL	50	120		<MDL	30	42
4-Methylphenol		<MDL	50	120		<MDL	30	42
Benzyl Butyl Phthalate		<MDL	40	60		<MDL	10	22
Benzoic Acid		<MDL	200	360		<MDL	90	130
Pesticides and PCBs (µg/kg dry weight)								
4,4' DDD		<MDL	1	3.1		<MDL	1	2.2
Aldrin		<MDL	1	3.1		<MDL	1	2.2
Aroclor 1248		<MDL	10	31		<MDL	10	22
Aroclor 1254		<MDL	10	31		<MDL	10	22
Aroclor 1260		<MDL	10	31		<MDL	10	22
Metals (mg/kg dry weight)								
Mercury	2.9	G	0.04	0.36		<MDL,G	0.03	0.25
Aluminum	24000		20	87	11000		10	59
Antimony		<MDL,G	9	45		<MDL,G	5	23
Arsenic	40	<RDL	9	44	9	<RDL	6	29
Beryllium	0.7	<RDL	0.2	0.87	0.4	<RDL	0.1	0.59
Cadmium	4.9		0.9	4.5		<MDL	0.4	1.8
Chromium	55		0.9	4.4	13		0.6	2.9
Copper	290		1	6.4	16		0.6	3
Iron	29000		9	44	19000		6	29
Lead	490		9	45		<MDL	4	18
Nickel	42		4	17	13		3	12
Selenium		<MDL	9	44		<MDL	6	29
Silver	13		1	6.4		<MDL	0.5	2.4
Thallium		<MDL	40	170		<MDL	30	120
Zinc	290		0.9	4.4	48		0.6	2.9

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limits
B - Blank contamination
E - Estimate
G - Low standard reference material recovery
L - High standard reference material recovery

Note: For further information on data qualifiers see Appendix B.

TABLE 3-5. Core C4, Detected Chemicals

Station/Section	C4 Undercap				C4 1st 6"				C4 2nd 6"			
Date	May 18, 93				May 18, 93				May 18, 93			
Sample Number	L1211-21				L1211-22				L1211-23			
% Solids	58				78				67			
% Total Organic Carbon	4				0.83							
BNA Organics (µg/kg dry weight)	**Value**	**Qual**	**MDL**	**RDL**	**Value**	**Qual**	**MDL**	**RDL**	**Value**	**Qual**	**MDL**	**RDL**
LPAHs												
Naphthalene	500		90	170		<MDL	40	64		<MDL	70	150
Acenaphthylene	450		30	57		<MDL	10	22	30	<RDL	30	49
Acenaphthene	190		20	47		<MDL	9	17	160		10	40
Fluorene	450		30	57		<MDL	10	22	220		30	49
Phenanthrene	2200		30	57	26	<RDL	10	22	1000		30	49
Anthracene	840		30	57		<MDL	10	22	360		30	49
2-Methylnaphthalene	100	<RDL	90	170		<MDL	40	64		<MDL	70	150
Total LPAHs	4730				145				1910			
HPAHs												
Fluoranthene	2100		30	69	45		10	26	1500		30	60
Pyrene	3100		30	57	38		10	22	960		30	49
Benzo(a)anthracene	1300		30	57	20		10	22	610		30	49
Chrysene	1700		30	57	27		10	22	700		30	49
Benzo(k)fluoranthene	1300		90	170		<MDL	40	64	390		70	150
Benzo(b)fluoranthene	2100		90	170		<MDL	40	64	480		70	150
Benzo(a)pyrene	1600		50	120		<MDL	30	42	360		40	100
Benzo(g,h,i)perylene	600		50	120		<MDL	30	42	240		40	100
Indeno(1,2,3-Cd)Pyrene	670		50	120		<MDL	30	42	240		40	100
Dibenzo(a,h)anthracene	200	<RDL	90	170		<MDL	40	64	100	<RDL	70	150
Total HPAHs	14670				340				5580			
Other BNAs												
Dibenzofuran	210		50	120		<MDL	30	42	130		40	100
Carbazole	190		50	120		<MDL	30	42		<MDL	40	100
2,4-Dimethylphenol		<MDL	50	120		<MDL	30	42		<MDL	40	100
4-Methylphenol		<MDL	50	120		<MDL	30	42		<MDL	40	100
Benzyl Butyl Phthalate		<MDL	30	57		<MDL	10	22		<MDL	30	49
Benzoic Acid		<MDL	200	340	190		90	130		<MDL	100	300
Pesticides and PCBs (µg/kg dry weight)												
4,4'-DDD		<MDL	1	2.9		<MDL	1	2.2		<MDL	1	2.5
Aldrin		<MDL	1	2.9		<MDL	1	2.2		<MDL	1	2.5
Aroclor 1248	34	<RDL	10	29		<MDL	10	22		<MDL	10	25
Aroclor 1254	20	<RDL	10	29		<MDL	10	22		<MDL	10	25
Aroclor 1260	100		10	29		<MDL	10	22	30	<RDL	10	25
Metals (mg/kg dry weight)												
Mercury	1.9	E	0	0.3	0.03	<RDL,E	0	0.3	0.1	<RDL,E	0	0.3
Aluminum	22000		20	84	11000		10	59	14000		10	75
Antimony		<MDL,G	9	45		<MDL,G	5	23		<MDL,G	6	33
Arsenic	20	<RDL	9	41	8	<RDL	6	29	10	<RDL	7	37
Beryllium	0.95		0.2	0.8	0.4	<RDL	0.1	0.6	0.4	<RDL	0.1	0.8
Cadmium	2	<RDL,L	0.9	4.5		<MDL,L	0.5	2.3		<MDL,L	0.6	3.3
Chromium	76		0.9	4.1	19		0.6	2.9	19		0.7	3.7
Copper	170		1	5.7	15		0.6	3.1	36		0.9	4.5
Iron	29000		9	41	21000		6	29	22000		7	37
Lead	240		9	45	4	<RDL	4	18	10	<RDL	4	22
Nickel	43		3	17	14		3	12	10	<RDL	3	15
Selenium		<MDL	9	41		<MDL	6	29		<MDL	7	37
Silver	2	<RDL	0.7	3.3		<MDL	0.5	2.4		<MDL	0.6	3
Thallium		<MDL	30	170		<MDL	30	120		<MDL	30	150
Zinc	170		0.9	4.1	51		0.6	2.9	67		0.7	3.7

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limits
B - Blank contamination
E - Estimate
G - Low standard reference material recovery
L - High standard reference material recovery

Note: For further information on data qualifiers see Appendix B.

TABLE 3-6. Core C5, Detected Chemicals

Station/Section	C5 Undercap				C5 1st 6"			
Date	May 18, 93				May 18, 93			
Sample Number	L1211-26				L1211-27			
% Solids	64				78			
% Total Organic Carbon	2.2				0.62			
BNA Organics (µg/kg dry weight)	**Value**	**Qual**	**MDL**	**RDL**	**Value**	**Qual**	**MDL**	**RDL**
LPAHs								
Naphthalene	100	<RDL	80	160		<MDL	40	64
Acenaphthylene	110		30	52		<MDL	10	22
Acenaphthene	97		20	42		<MDL	9	17
Fluorene	150		30	52		<MDL	10	22
Phenanthrene	750		30	52	10	<RDL	10	22
Anthracene	390		30	52		<MDL	10	22
2-Methylnaphthalene		<MDL	80	160		<MDL	40	64
Total LPAHs	1677				129			
HPAHs								
Fluoranthene	800		30	63	28		10	26
Pyrene	1700		30	52	31		10	22
Benzo(a)anthracene	640		30	52	10	<RDL	10	22
Chrysene	830		30	52	10	<RDL	10	22
Benzo(k)fluoranthene	560		80	160		<MDL	40	64
Benzo(b)fluoranthene	920		80	160		<MDL	40	64
Benzo(a)pyrene	720		50	100		<MDL	30	42
Benzo(g,h,i)perylene	330		50	100		<MDL	30	42
Indeno(1,2,3-Cd)Pyrene	380		50	100		<MDL	30	42
Dibenzo(a,h)anthracene	170		80	160		<MDL	40	64
Total HPAHs	7050				289			
Other BNAs								
Dibenzofuran	90	<RDL	50	100		<MDL	30	42
Carbazole	110		50	100		<MDL	30	42
2,4-Dimethylphenol		<MDL	50	100		<MDL	30	42
4-Methylphenol		<MDL	50	100		<MDL	30	42
Benzyl Butyl Phthalate		<MDL	30	52		<MDL	10	22
Benzoic Acid		<MDL	200	310		<MDL	90	130
Pesticides and PCBs (µg/kg dry weight)								
4,4'-DDD		<MDL	1	2.7		<MDL	1	2.2
Aldrin		<MDL	1	2.7	1	<RDL	1	2.2
Aroclor 1248	20	<RDL	10	27		<MDL	10	22
Aroclor 1254	56		10	27		<MDL	10	22
Aroclor 1260	120		10	27		<MDL	10	22
Metals (mg/kg dry weight)								
Mercury	0.86	E	0.03	0.31	0.04	<RDL,E	0.03	0.26
Aluminum	19000		10	73	10000		10	59
Antimony		<MDL,G	8	34		<MDL,G	5	23
Arsenic	20	<RDL	8	38	6	<RDL	6	29
Beryllium	0.6	<RDL	0.1	0.73	0.4	<RDL	0.1	0.59
Cadmium	1	<RDL,L	0.8	3.4		<MDL,L	0.5	2.3
Chromium	44		0.8	3.8	14		0.6	2.9
Copper	95		0.9	4.7	17		0.6	2.9
Iron	25000		8	38	19000		6	29
Lead	150		8	34	5	<RDL	4	18
Nickel	42		3	15	14		3	12
Selenium		<MDL	8	38		<MDL	6	29
Silver	2	<RDL	0.6	3		<MDL	0.5	2.3
Thallium		<MDL	30	150		<MDL	30	120
Zinc	110		0.8	3.8	53		0.6	2.9

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limits
B - Blank contamination
E - Estimate
G - Low standard reference material recovery
L - High standard reference material recovery

Note: For further information on data qualifiers see Appendix B.

TABLE 3-7. Cores C1 and C3, Comparison of Cores to Standards

Station/Section	C1 Undercap		C1 1st 6"		C3 Undercap		C3 1st 6"		Sediment Management Standards	
Date	May 18, 93		May 18, 93		May 19, 93		May 19, 93			
Sample Number	L1211-1		L1211-2		L1211-16		L1211-17			
% Solids	55		78		55		79			
% Total Organic Carbon	6.9		1.5		5.1		0.78			
Organics									SQS Table I	CSL Table III
LPAHs (mg/kg TOC)	Value	Qual	Value	Qual	Value	Qual	Value	Qual		
Naphthalene	5.2		2.7	<MDL	1.8	<MDL	5.1	<MDL	99	170
Acenaphthylene	5.8		0.67	<MDL	4.3		1.3	<MDL	66	66
Acenaphthene	4.5		0.6	<MDL	2.7		1.2	<MDL	16	57
Fluorene	7.4		0.67	<MDL	4.3		1.3	<MDL	23	79
Phenanthrene	39		0.67	<MDL	25		5		100	480
Anthracene	17		0.67	<MDL	13		1.3	<MDL	220	1200
2-Methylnaphthalene	2.6	<RDL	2.7	<MDL	1.8	<RDL	5.1	<MDL	38	64
Total LPAHs	81.5		8.68		52.9		20.3		370	780
HPAHs (mg/kg TOC)										
Fluoranthene	45		3		24		8.7		160	1200
Pyrene	84		2.1		61		6.8		1000	1400
Benzo(a)anthracene	48		0.67	<MDL	25		3.7		110	270
Chrysene	65		0.67	<RDL	33		3.8		110	460
Total benzofluoranthenes	155		5.4	<MDL	90		10.2	<RDL	230	450
Benzo(a)pyrene	58		2	<MDL	35		3.8	<MDL	99	210
Indeno(1,2,3-Cd)Pyrene	16		2	<MDL	10		3.8	<MDL	34	88
Dibenzo(a,h)anthracene	19		2	<MDL	15		3.8	<MDL	12	33
Benzo(g,h,i)perylene	1.3	<MDL	2.7	<MDL	1.8	<MDL	5.1	<MDL	31	78
Total HPAHs	493.62		23.22		297.9		54.9		960	5300
Other (mg/kg TOC)										
1,2-Dichlorobenzene	0.58	<MDL	0.67	<MDL	0.78	<MDL	1.3	<MDL	2.3	2.3
1,4-Dichlorobenzene	0.58	<MDL	0.67	<MDL	0.78	<MDL	1.3	<MDL	3.1	9
1,2,4-Trichlorobenzene	0.58	<MDL	0.67	<MDL	0.78	<MDL	**1.3***	<MDL	0.81	1.8
Hexachlorobenzene	**0.58***	<MDL	**0.67***	<MDL	**0.78***	<MDL	**1.3***	<MDL	0.38	2.3
Diethyl Phthalate	0.72	<MDL	2	<MDL	0.98	<MDL	3.8	<MDL	61	110
Dimethyl Phthalate	0.29	<MDL	0.6	<MDL	0.39	<MDL	1.2	<MDL	53	53
Di-N-Butyl Phthalate	0.72	<MDL	2	<MDL	0.98	<MDL	3.8	<MDL	220	1700
Benzyl Butyl Phthalate	0.58	<MDL	0.67	<MDL	0.78	<MDL	1.3	<MDL	4.9	64
Bis(2-Ethylhexyl)Phthalate	0.58	<MDL,B	0.67	<MDL,B	0.78	<MDL,B	1.3	<MDL,B	47	78
Di-N-Octyl Phthalate	0.58	<MDL	0.67	<MDL	0.78	<MDL	1.3	<MDL	58	4500
Dibenzofuran	4.8		2	<MDL	3.1		3.8	<MDL	15	58
Hexachlorobutadiene	0.72	<MDL	2	<MDL	0.98	<MDL	3.8	<MDL	3.9	6.2
N-Nitrosodiphenylamine	0.72	<MDL	2	<MDL	0.98	<MDL	3.8	<MDL	11	11
Total PCBs	**23.9***		2	<MDL	0.19	<MDL	1.3	<MDL	12	65
Other (ug/kg dry weight)										
Phenol	200	<MDL	90	<MDL	200	<MDL	90	<MDL	420	1200
2-Methylphenol	50	<MDL	30	<MDL	50	<MDL	30	<MDL	63	63
4-Methylphenol	50	<MDL	30	<MDL	50	<MDL	30	<MDL	670	670
2,4-Dimethylphenol	**50***	<MDL	**30***	<MDL	**50****	<MDL	**30****	<MDL	29	29
Pentachlorophenol	50	<MDL	30	<MDL	50	<MDL	30	<MDL	360	690
Benzyl Alcohol	200	<MDL	90	<MDL	200	<MDL	90	<MDL	57	73
Benzoic Acid	50	<MDL	30	<MDL	50	<MDL	30	<MDL	650	650
Metals (mg/kg dry weight)										
Mercury	**2.9****	G	0.03	<MDL,G	**2.9****	G	0.03	<MDL,G	0.41	0.59
Arsenic	40	<RDL	9	<RDL	40	<RDL	9	<RDL	57	93
Cadmium	**11****		0.4	<MDL	4.9		0.4	<MDL	5.1	6.7
Chromium	100		17		55		13		260	270
Copper	360		18		290		16		390	390
Lead	**890****		5	<RDL	**490***		4	<MDL	450	530
Silver	**22****		0.5	<MDL	**13****		0.5	<MDL	6.1	6.1
Zinc	380		59		290		48		410	960

* - Exceeds SQS
** - Exceeds CSL
<MDL - Undetected at the method detection limit
E - Estimate
<RDL - Detected below reporting detection limits
G - Low standard reference material recovery
B - Blank contamination
L - High standard reference material recovery
Note: For further information on data qualifiers see Appendix B.

TABLE 3-8. Cores C2 and C2 Replicate, Comparison of Cores to Standards

Station/Section	C2 Undercap		C2 1st 6"		C2 Undercap Rep		C2 1st 6" Rep		Sediment Management Standards	
Date	May 18, 93		May 18, 93		May 18, 93		May 18, 93			
Sample Number	L1211-6		L1211-7		L1211-11		L1211-12			
% Solids	54		81		41		82			
% Total Organic Carbon	7.2		0.12		12		0.6			
Organics									SQS Table I	CSL Table III
LPAHs (mg/kg TOC)	**Value**	**Qual**	**Value**	**Qual**	**Value**	**Qual**	**Value**	**Qual**		
Naphthalene	4.3		33	<MDL	5.8	<MDL	6.7	<MDL	99	170
Acenaphthylene	3.6		8.3	<MDL	1.7	<MDL	1.7	<MDL	66	66
Acenaphthene	6.9		7.5	<MDL	8.3		1.5	<MDL	16	57
Fluorene	7.5		8.3	<MDL	7		1.7	<MDL	23	79
Phenanthrene	61		8.3	<MDL	5		1.7	<MDL	100	480
Anthracene	13		8.3	<MDL	20		1.7	<MDL	220	1200
2-Methylnaphthalene	3.3		33	<MDL	5.8	<MDL	6.7	<MDL	38	64
Total LPAHs	99.6		107		53.6		21.7		370	780
HPAHs (mg/kg TOC)										
Fluoranthene	42		8.3	<RDL	79		1.7	<RDL	160	1200
Pyrene	60		8.3	<MDL	69		1.7	<RDL	1000	1400
Benzo(a)anthracene	43		8.3	<MDL	41		1.7	<MDL	110	270
Chrysene	49		8.3	<MDL	49		1.7	<MDL	110	460
Total benzofluoranthenes	90		66	<MDL	69		13.4	<MDL	230	450
Benzo(a)pyrene	42		17	<MDL	27		3.3	<MDL	99	210
Indeno(1,2,3-Cd)Pyrene	12		17	<MDL	10		3.3	<MDL	34	88
Dibenzo(a,h)anthracene	17		17	<MDL	15		3.3	<MDL	12	33
Benzo(g,h,i)perylene	5.1		33*	<MDL	5.8	<MDL	6.7	<MDL	31	78
Total HPAHs	362.34		216		371.6		43.6		960	5300
Other (mg/kg TOC)										
1,2-Dichlorobenzene	0.56	<MDL	8.3**	<MDL	1.7	<MDL	1.7	<MDL	2.3	2.3
1,4-Dichlorobenzene	0.56	<MDL	8.3*	<MDL	1.7	<MDL	1.7	<MDL	3.1	9
1,2,4-Trichlorobenzene	0.56	<MDL	8.3**	<MDL	1.7*	<MDL	1.7*	<MDL	0.81	1.8
Hexachlorobenzene	0.56*	<MDL	8.3**	<MDL	1.7*	<MDL	1.7*	<MDL	0.38	2.3
Diethyl Phthalate	0.83	<MDL	17	<MDL	4.2	<MDL	3.3	<MDL	61	110
Dimethyl Phthalate	0.28	<MDL	7.5	<MDL	1.7	<MDL	1.5	<MDL	53	53
Di-N-Butyl Phthalate	0.83	<MDL	17	<MDL	4.2	<MDL	3.3	<MDL	220	1700
Benzyl Butyl Phthalate	3.3		8.3*	<MDL	1.7	<MDL	1.7	<MDL	4.9	64
Bis(2-Ethylhexyl)Phthalate	0.56	<MDL,B	8.3	<MDL,B	1.7	<MDL,B	1.7	<MDL,B	47	78
Di-N-Octyl Phthalate	0.56	<MDL	8.3	<MDL	1.7	<MDL	1.7	<MDL	58	4500
Dibenzofuran	3.6		17*	<MDL	4.2	<MDL	3.3	<MDL	15	58
Hexachlorobutadiene	0.83	<MDL	17**	<MDL	4.2*	<MDL	3.3	<MDL	3.9	6.2
N-Nitrosodiphenylamine	0.83	<MDL	17**	<MDL	4.2	<MDL	3.3	<MDL	11	11
Total PCBs	24.5*		8.3	<MDL	90.4**		1.7	<MDL	12	65
Other (ug/kg dry weight)										
Phenol	200	<MDL	90	<MDL	2000**	<MDL	90	<MDL	420	1200
2-Methylphenol	60	<MDL	20	<MDL	500**	<MDL	20	<MDL	63	63
4-Methylphenol	300		20	<MDL	500	<MDL	20	<MDL	670	670
2,4-Dimethylphenol	60**	<MDL	20	<MDL	4400**		20	<MDL	29	29
Pentachlorophenol	60	<MDL	20	<MDL	500*	<MDL	20	<MDL	360	690
Benzyl Alcohol	200	<MDL	90	<MDL	2000**	<MDL	90	<MDL	57	73
Benzoic Acid	60**	<MDL	20	<MDL	500**	<MDL	20	<MDL	650	650
Metals (mg/kg dry weight)										
Mercury	6.9**	G	0.02	<MDL,G	18**	G	0.02	<RDL,G	0.41	0.59
Arsenic	40	<RDL	10	<RDL	20	<RDL	7	<RDL	57	93
Cadmium	16**		0.4	<MDL	100**		0.4	<MDL	5.1	6.7
Chromium	98		17		510**		13		260	270
Copper	480**		17		2200**		15		390	390
Lead	810**		5	<RDL	1500**		5	<RDL	450	530
Silver	52**		0.5	<MDL	140**		0.5	<MDL	6.1	6.1
Zinc	670*		52		1400**		45		410	960

* - Exceeds SQS
** - Exceeds CSL
<MDL - Undetected at the method detection limit
E - Estimate
<RDL - Detected below reporting detection limits
G - Low standard reference material recovery
B - Blank contamination
L - High standard reference material recovery

Note: For further information on data qualifiers see Appendix B.

TABLE 3-9. Core C4 and C5, Comparison of Cores to Standards

Station/Section	C4 Undercap		C4 1st 6"		C5 Undercap		C5 1st 6"		Sediment Management Standards	
Date	May 18, 93		May 18, 93		May 18, 93		May 18, 93			
Sample Number	L1211-21		L1211-22		L1211-26		L1211-27			
% Solids	58		78		64		78			
% Total Organic Carbon	4		0.83		2.2		0.62		SQS Table I	CSL Table III
Organics										
LPAHs (mg/kg TOC)	Value	Qual	Value	Qual	Value	Qual	Value	Qual		
Naphthalene	12		4.8	<MDL	4.5	<RDL	6.5	<MDL	99	170
Acenaphthylene	11		1.2	<MDL	5		1.6	<MDL	66	66
Acenaphthene	4.7		1.1	<MDL	4.4		1.4	<MDL	16	57
Fluorene	11		1.2	<MDL	6.8		1.6	<MDL	23	79
Phenanthrene	55		3.1	<RDL	34		1.6	<RDL	100	480
Anthracene	21		1.2	<MDL	18		1.6	<MDL	220	1200
2-Methylnaphthalene	2.5	<RDL	4.8	<MDL	3.6	<MDL	6.5	<MDL	38	64
Total LPAHs	117.2		17.4		76.3		20.8		370	780
HPAHs (mg/kg TOC)										
Fluoranthene	52		5.4		36		4.5		160	1200
Pyrene	77		4.6		77		5		1000	1400
Benzo(a)anthracene	32		2.4		29		1.6	<RDL	110	270
Chrysene	42		3.3		38		1.6	<RDL	110	460
Total benzofluoranthenes	84		9.6	<MDL	67		13	<MDL	230	450
Benzo(a)pyrene	40		3.6	<MDL	33		4.8	<MDL	99	210
Indeno(1,2,3-Cd)Pyrene	15		3.6	<MDL	15		4.8	<MDL	34	88
Dibenzo(a,h)anthracene	17		3.6	<MDL	17		4.8	<MDL	12	33
Benzo(g,h,i)perylene	5	<RDL	4.8	<MDL	7.7		6.5	<MDL	31	78
Total HPAHs	367		45.7		325.3		53		960	5300
Other (mg/kg TOC)										
1,2-Dichlorobenzene	0.75	<MDL	1.2	<MDL	1.4	<MDL	1.6	<MDL	2.3	2.3
1,4-Dichlorobenzene	0.75	<MDL	1.2	<MDL	1.4	<MDL	1.6	<MDL	3.1	9
1,2,4-Trichlorobenzene	0.75	<MDL	1.2*	<MDL	1.4*	<MDL	1.6*	<MDL	0.81	1.8
Hexachlorobenzene	0.75*	<MDL	1.2*	<MDL	1.4*	<MDL	1.6*	<MDL	0.38	2.3
Diethyl Phthalate	1.2	<MDL	3.6	<MDL	2.3	<MDL	4.8	<MDL	61	110
Dimethyl Phthalate	0.5	<MDL	1.1	<MDL	0.91	<MDL	1.5	<MDL	53	53
Di-N-Butyl Phthalate	1.2	<MDL	3.6	<MDL	2.3	<MDL	4.8	<MDL	220	1700
Benzyl Butyl Phthalate	0.75	<MDL	1.2	<MDL	1.4	<MDL	1.6	<MDL	4.9	64
Bis(2-Ethylhexyl)Phthalate	0.75	<MDL,B	1.2	<MDL,B	1.4	<MDL,B	1.6	<MDL,B	47	78
Di-N-Octyl Phthalate	0.75	<MDL	1.2	<MDL	1.4	<MDL	1.6	<MDL	58	4500
Dibenzofuran	5.2		3.6	<MDL	4.1	<RDL	4.8	<MDL	15	58
Hexachlorobutadiene	1.2	<MDL	3.6	<MDL	2.3	<MDL	4.8	<MDL	3.9	6.2
N-Nitrosodiphenylamine	1.2	<MDL	3.6	<MDL	2.3	<MDL	4.8*	<MDL	11	11
Total PCBs	3.85		1.2	<MDL	8.9		1.6	<MDL	12	65
Other (ug/kg dry weight)										
Phenol	200	<MDL	90	<MDL	200	<MDL	90	<MDL	420	1200
2-Methylphenol	50	<MDL	30	<MDL	50	<MDL	30	<MDL	63	63
4-Methylphenol	50	<MDL	30	<MDL	50	<MDL	30	<MDL	670	670
2,4-Dimethylphenol	50**	<MDL	30**	<MDL	50**	<MDL	30**	<MDL	29	29
Pentachlorophenol	50	<MDL	30	<MDL	50	<MDL	30	<MDL	360	690
Benzyl Alcohol	200	<MDL	190		200	<MDL	90	<MDL	57	73
Benzoic Acid	50	<MDL	30	<MDL	50	<MDL	30	<MDL	650	650
Metals (mg/kg dry weight)										
Mercury	1.9**	E	0.03	<RDL,E	0.86**	E	0.04	<RDL,E	0.41	0.59
Arsenic	20	<RDL	8	<RDL	20	<RDL	6	<RDL	57	93
Cadmium	2	<RDL,L	0.5	<MDL,L	1	<RDL,L	0.5	<MDL,L	5.1	6.7
Chromium	76		19		44		14		260	270
Copper	170		15		95		17		390	390
Lead	240		4	<RDL	150		5	<RDL	450	530
Silver	2	<RDL	0.5	<MDL	2	<RDL	0.5	<MDL	6.1	6.1
Zinc	170		51		110		53		410	960

* - Exceeds SQS
** - Exceeds CSL
<MDL - Undetected at the method detection limit
E - Estimate
<RDL - Detected below reporting detection limits
G - Low standard reference material recovery
B - Blank contamination
L - High standard reference material recovery

For further information on data qualifiers see Appendix B

TABLE 3-10. Cores C1 and C2, Particle Size Distribution

Station/Section	C1 Under Cap	C1 1st 6"	C2 Under Cap	C2 1st 6"
Date	May 18, 93	May 18, 93	May 18, 93	May 18, 93
Sample Number	L1211-1	L1211-2	L1211-6	L1211-7
% Solids	55	78	54	81
Phi Size (%)				
Sands and Gravels				
p-2.25		0.4 E	0.2 E	0.6 E
p-2.00		0.1 E		0.8 E
p-1.00		0.9 E	0.9 E	1.3 E
p+0.00		3.4 E	2.2 E	7.7 E
p+1.00		37 E	5 E	41 E
p+2.00		46 E	6.8 E	38 E
p+3.00		7.5 E	7.4 E	5.5 E
p+4.00		1 E	7.9 E	0.8 E
Total % Sands		95	29	93
Silts and Clays				
p+5.00		1 F	12 E	1.1 E
p+6.00			11 E	
p+7.00		0.8 E	12 E	0.8 E
p+8.00		1.6 E	12 E	0.5 E
p+9.00		0.2 E	7.6 E	
p+10.0			15 E	1.3 E
Total % Silts and Clays		3.6	70	3.7

E - Estimate

TABLE 3-11. Cores C2 and C3, Particle Size Distribution

Station/Section	C2 Under Cap Rep	C2 1st 6" Rep	C3 Under Cap	C3 1st 6"
Sampled	May 18, 93	May 18, 93	May 19, 93	May 19, 93
Sample Number	L1211-11	L1211-12	L1211-16	L1211-17
% Solids	41	82	55	79
Phi Size (%)				
Sands and Gravels				
p-2.25		0.9 E		0.1 E
p-2.00		0.3 E		
p-1.00		1.4 E		0.9 E
p+0.00		6.5 E		5.6 E
p+1.00		46 E		28 E
p+2.00		39 E		50 E
p+3.00		3.3 E		7.8 E
p+4.00		0.4 E		1.4 E
Total % Sands		97.8		93.8
Silts and Clays				
p+5.00		0.2 E		0.8 E
p+6.00				0.5 E
p+7.00				1.2 E
p+8.00		1.1 E		1.9 E
p+9.00		0.2 E		0.3 E
p+10.0		1.3 E		1.3 E
Total % Silts and Clays		2.8		6

E - Estimate

TABLE 3-12. Cores C4 and C5, Particle Size Distribution					
Station/Section	**C4 Under Cap**	**C4 1st 6"**	**C4 2nd 6"**	**C5 Under Cap**	**C5 1st 6"**
Sampled	**May 18, 93**	**May 18, 93**	**May 18, 93**	**May 18, 93**	**May 18, 93**
Sample Number	**L1211-21**	**L1211-22**	**L1211-23**	**L1211-26**	**L1211-27**
% Solids	**58**	**78**	**67**	**64**	**78**
Phi Size (%)					
Sands and Gravels					
p-2.25	6.7 E	0.1 E		2 E	1.9 E
p-2.00	0.7 E	0.1 E		0.2 E	
p-1.00	2.4 E	0.6 E		0.8 E	1.1 E
p+0.00	2.2 E	3.7 E		0.8 E	4.3 E
p+1.00	2.9 E	28 E		1.7 E	33 E
p+2.00	4.8 E	55 E		11 E	50 E
p+3.00	3.8 E	6.8 E		16 E	5 E
p+4.00	4.6 E	1.2 E		8.8 E	0.5 E
Total % Sands	18	95		38	93
Silts and Clays					
p+5.00	5.6 E	1 E		14 E	2.6 E
p+6.00	15 E			8.1 E	
p+7.00	17 E			8.9 E	
p+8.00	13 E	1.1 E		9.1 E	
p+9.00	6.4 E	0.2 E		6 E	
p+10.0	15 E	1.3 E		13 E	1.3 E
Total % Silts and Clays	72	3.6		59	3.9

E - Estimate